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STUDY OF THE CONSTRAINTS TO TECHNOLOGY DEVELOPMENT AND APPLICATION IN THE MINING SECTOR

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Part I Background & Introduction

Increasing international competition is forcing Canadian industries to examine ways and means of improving their productivity in order to maintain a competitive status in the global marketplace. This is particularly true of Canadian mining companies which face stiff competition from countries which benefit from preferential trading arrangements, financing and currency advantages.

The key role that new technology will play in productivity improvements is well documented and increasingly recognized. Dr. Walter Curlook of Inco stated in a recent address to the Prospectors and Developers Association:

> **"We all know, that productivity improvements come from changes and improvements in many areas: in methods, technology, equipment, simplification, work re-organizations, job restructuring, computerization, automation. We all know, too, that in order to make quantum improvements in productivity and achieve significant reductions in cost that we must move in all these areas at the same time."**

Obviously, the development and application of new technologies can provide the desparately needed productivity boosts. Yet, a survey of 32 industries published in Business Week magazine last year indicates that research and development expenditures as a percentage of pre-tax income for the mining sector is the second lowest. Furthermore, the five year growth rate of these expenditures is less than half of a comparable industry - forestry.

Although the figures are based on American industry, it would be foolishly optimistic to assume that the Canadian mining industry would fare much better in a similar comparison. One estimate suggests that the Canadian mining industry devotes less that 1% of gross revenue to research and development and market research combined.

Does this reflect a reliance on the part of the industry toward externally developed technology? What factors deter the development and application of new technologies in the mining sector? What role can the government play in encouraging the industry to become more active in the development and application of productivity enhancing technologies? This study examines some of these questions through the views of the industry itself.

Approach

To provide CANMET with the mining industry's perspective of the barriers and constraints to the application and development of technology, data gathering was conducted by the use of a mailed survey.

Bevelander & Company compiled a mailing list using various sources including The Canadian Mines Handbook, Energy, Mines and Resources' database, the Mining Association of Canada and previous CANMET studies. The resulting list was refined and up-dated as much as possible through telephone contact with some of the firms. The final mailing list included 448 contact names and titles representing three levels of the organization: Executive, Research and Operating Management.

A draft questionnaire was developed and reviewed with CANMET and MAC officials. After minor modifications the questionnaire was "pre-tested" with several senior mining executives to determine ease of use and impact. The pre-testing led to some further changes and clarifications before the questionnaire was finalized. At this point the questionnaire was translated into French and then typeset in both official languages.

Bevelander & Company drafted covering letters in French and English for both CANMET and MAC officials, to be included in the survey packages. The questionnaire and covering letters were printed and sent to the 448 individuals along with prepaid reply envelopes. Those with Quebec addresses were sent French versions of the survey packages.

Two weeks after this mailing, reminder letters were sent to all the contacts, again requesting their participation. Copies of the questionnaires and letters are included in Appendix A.

Part II Executive Summary

A total of 177 questionnaires were returned giving a 39.5% response rate. The questionnaires were directed at individuals within three levels of the corporate structure: Executives, Research and Operating Management. The responses cover each of the three levels and all types of operations. Thirty-five percent are in the Executive group, 25% in Research and the remaining forty percent in Operating Management. The majority came from organizations which operate less than four mines in Canada. The three groups are well distributed across type of operation with approximately equal representation from organizations that operate underground only, open-pit only, mixed and those that have smelters.

Respondents were asked to identify what and when was the most recent installation or application of a new process or piece of equipment in their operation. Seventy-two percent indicated that the most recent was in 1985-1986. Another 26% indicated the period between 1980-1984. This is important because not only does it demonstrate that the industry is currently active in innovating or upgrading but that the subsequent specific questions regarding this installation reflect not a historical or traditional perspective but the way things are being done now. Of these recent installations, 55% are pure purchase while another 18% are putting value added work on purchased goods. Only 13% are developed solely in-house.

Forty-five percent indicated that their operations had some state-of-the-art equipment/process and 46 % said they had mostly state of the art. The most recent applications or installations of new technology were predominately purchased with 55% pure puchases and 18% purchased and adapted in-house. While 56% indicated the presence of a formal research and development group, only 13% of the most recent installations were developed solely in-house.

The need for 77% of these recent applications was identified by either the Operating Management and Staff (48%) or the R&D/Technology Management (29%). Seven percent was identified by a combination of all groups. Almost half of the recent installations were driven by the operations people. Also, it is common practice (74%) among respondents for those that identified the need to also be responsible for finding the technological solutions. In 61% of the cases, that same person/group also presented the project to the executive for approval to implement.

This supports the concept of champions as defined by Edward Roberts, Sloan School M.I.T. - one entrepreneurial person/group pushing change internally through the organizational systems as the major vehicle for innovation.

The most frequently cited factors influencing the decision to implement the recent applications were Cost Savings and Productivity Improvements. The factors rated as major barriers to the introduction of new technology were Cash Availability (73%) and Risk Involved in Unproven Technology (66%). Despite this there seems to be a trend toward increasing, within the next three years, expenditures in recent technology (36%) versus time tested technology (18%).

Government programs enjoy a high level of awareness within the respondent groups. This is particularly true of tax incentives, however responses to the open-ended questions repeatedly point out that tax incentives are of little value when the firms are suffering losses.

Another finding is that although the Operations groups is responsible for identifying 48% of the needs for technology application, they are generally less aware of available government assistance directed at technology transfer, development and modernization. This is supplemented by the results of the open-ended questions in which the Operations group suggested seminars and on-site courses on available assistance and research activities.

The answers to section A through E of the questionnaire are supported by the opinions and suggestions provided by respondents in Section F. Noted anthropologist, Clifford Geertz once commented:

> **"What we call our data are really our own constructions of other people's construction of what they or their compatriots are up to ...Explanations often consist of substituting complex pictures for simple ones while striving somehow to retain the persuasive clarity that went with the simple ones"**

With this in mind, quite simply, the challenge defined by the respondents is that the need to innovate in order to increase productivity and remain competitive comes at a time when the industry is cash poor and operating in uncertain markets.

Their solution, equally simply, is to increase the liaison between all the players in the innovation process and more co-operation between members of the industry itself.

Part III Comments and Recommendations

Perhaps, the survey's most interesting findings are:

a) The need for almost half of the recent applications of technology was originally identified by operating management and staff

b) Executives do not rank technology in the top five (out of nine) factors contributing to profitability.

c) Although 56% have the presence of a formal research and development group, only 13% of the most recent installations were developed in-house.

The results indicate that the industry is operating on a "up-from-the-bottom" approach to technological applications. Although this approach affords many advantages and allows room for important incremental improvements in many phases of the mining process, it also imposes severe limitations. Such a heavy emphasis on operations driven proposals may well tend to minimize pressures for far-reaching new kinds of technology. Clearly it does not suggest the existence of an overall corporate technology strategy.

It must be recognized, however, that major technological improvements usually involve substantial investments and risks in addition to taking extended periods before their full potentials are likely to be realized. Therefore, major technological advances are unlikely to be effected unless top

management establishes them as a priority. Only when the chief executive officer makes the commitment will the climate for change be established and, only then, are the conditions right for the company to develop and apply advanced technologies. But private firms are not in business to advance technology or even to maximize productivity. They are in business to achieve and maintain attractive rates of profitability and senior management does not perceive technology to be a key factor to that profitability.

The most frequently cited factor influencing the decision to implement the recent applications was "cost savings". How well equipped are the operations people to present the executive with an analytical framework which facilitates tracing the probable effects of technological innovations beyond productivity to the resulting impacts on costs and profits? Are they adequately well versed in corporate financing and long term goals to explain the significance of major technical projects to the current and future business of the corporation? Their geographic remoteness from where corporate priorities are set combined with the urgency of day-to-day operations doesn't allow for the development of such a comprehensive analytical framework. As one respondent eloquently commented "industry is often too busy fighting fires to design a better fire retardent" - let alone develop a justifiable financial case for the fire retardent.

That over half the respondents stated that they have a formal research and development group seems contradictory at first, especially in light of the finding that only 13% of recently installed technology was developed in-house. The results seem to indicate that the research and development functions are not often charged with the responsibility to invent but rather to adapt existing technology and embody in-house scientific and technical knowledge in support of the operation. They are the collectors of technology related information and key players in the technology transfer process.

The survey also shows that the Research group obtains more value in terms of sources of technology-related information from conferences, universities, government laboratories than the other two groups. They form the linkages to the scientific community and are the loci for information exchange.

For CANMET, this means that linkages may already exist with the researchers in the mining industry; these should be encouraged and strengthened. However, there is ample room for improving liaisons with the Operations group which not only identifies the need for much of the innovation but also ultimately has to apply it.

Operations is generally less aware of government programs and incentives than either of the other two groups. They currently do not perceive much value in government

laboratories or departments in terms of technology related information sources and yet combined with the Research group they are responsible for identifying the need for 77% of the recent installations.

Originally, this project was envisioned as including focus groups of industry representatives centred around issues and barriers to technology application and diffusion in the mining industry. Based on the results of the survey outlined in this report, it is recommended that this phase of the project be undertaken and structured as follows:

i) Focus groups be conducted across Canada.

ii) Three of the focus groups deal with how to improve the liaison between government, industry and universities. These would include representatives from each and discussions would centre around what is currently deterring the liaison and how to overcome these obstacles.

iii) Three focus groups would include mining industry representatives only and address how to increase technology related co-operation between them. Emphasis in these sessions might be on how to encourage the junior companies' involvement in research.

iv) The seventh focus group would address the need for more technology related information as particularly evidenced in the Operations group. Industry members would be asked to discuss the type of information required, the vehicles for dissemination and CANMET's role in the process.

These sessions will serve to encourage a national dialogue on technology diffusion in mining and heighten awareness of the issue. As well, from the discussions, concrete action plans can be developed to alleviate some of the constraints and enhance information dissemination within the mining industry.

Part IV Survey Results

Section A: General Profile

One hundred and seventy-seven questionnaires were returned giving a significant response rate of 39.5%. The responses were compiled, coded tabulated, and entered into a CPM system and compiled on a Prime computer.
The responses covered each of the three levels of the organizations with 35% in Executive, 25% in Research and 40% in Operating Management. At the request of the client, the sample was also subdivided by type of operations as follows:

i) operators of underground mines but no open pit - 32%
ii) operators of open pit mines but no underground - 26%
iii) operators of both underground and open pit mines - 37%
iv) operators of smelters and refining plants - 36%

Throughout this report, the term "sample" refers to the entire respondent population of 177. The term "sub-sample" is used in a specific manner to refer to one of the above types of operations. The term "group" denotes one of the three identified levels of the organization (ie. Executive, Research, Operations).

The majority of respondents come from organizations that operate less than four mines. The distribution of the groups across subsamples is relatively homogenous with representation from each level of the organization in each type of operation.

Section B: Utilization of Technologies

In Section B, respondents were asked to rate nine factors in terms of their potential contribution to profitability. The vast majority of the sample (88%) rated " Management" as providing significantly to the profitability of the operation. This was followed by Cost Control and Labour Force with 74% and 73% respectively. The lowest ratings went to Exploration and Diversification with only 34% and 17% of the respondents giving positive ratings. Within the groups, however, the factors were rated differently with the most marked deviation in the Research group's evaluation of Technology. The following charts highlight these differences.

Because the number of respondents in each group varies, the charts for most questions are necessarily based on percentages and averages (mean). The ranking by respondents of the top five factors are presented directly below the rating charts for each group.

Question 3: **Please rate the following factors in terms of their potential contribution to profitability and rank the top five.**

Ratings - Total Sample

Factors	Percentage Positive Rating	Mean Rating
1. Management	88%	4.4
2. Cost Control	74%	4.0
3. Labour Force	73%	4.1
4. Equipment Maintenance	61%	3.6
5. Technology	60%	3.7
6. Marketing	40%	3.1
7. Exploration	34%	2.9
8. End Product Devel't	22%	2.5
9. Diversification	17%	2.3

Rankings - Total Sample

Factors	Percentage In Top Five	Mean Ranking
1. Management	72%	3.0
2. Labour Force	69%	2.3
3. Cost Control	64%	1.9
4. Equipment Maintenance	52%	1.1
5. Technology	49%	1.2
6. Marketing	32%	.9
7. Exploration	26%	.6
8. End Product Devel't	10%	.2
9. Diversification	9%	.2

Question 3: **Please rate the following factors in terms of their potential contribution to profitability and rank the top five.**

Ratings - Executive Group

Factors	Percentage Positive Rating	Mean Rating
1. Management	90%	4.4
2. Cost Control	83%	4.2
3. Labour Force	75%	4.1
4. Equipment Maintenance	62%	3.7
5. Technology	56%	3.7
6. Marketing	43%	3.1
7. Exploration	25%	2.8
8. End Product Devel't	21%	2.5
9. Diversification	11%	2.3

Rankings - Executive Group

Factors	Percentage In Top Five	Mean Ranking
1. Management	86%	3.8
2. Labour Force	84%	2.5
3. Cost Control	76%	2.4
4. Equipment Maintenance	54%	1.1
5. Marketing	50%	1.3
6. Technology	49%	1.0
7. Exploration	27%	.6
8. End Product Devel't	9%	.2
9. Diversification	2%	.1

Question 3: **Please rate the following factors in terms of their potential contribution to profitability and rank the top five.**

Ratings - Research Group

Factors	Percentage Positive Rating	Mean Rating
1. Management	84%	4.3
2. Technology	70%	3.9
3. Cost Control	60%	3.7
4. Labour Force	58%	3.9
5. Equipment Maintenance	43%	3.4
6. Exploration	41%	3.0
7. Marketing	35%	3.0
8. Diversification	29%	2.4
9. End Product Devel't	26%	2.6

Rankings -Research Group

Factors	Percentage In Top Five	Mean Ranking
1. Management	74%	2.9
2. Technology	68%	1.9
3. Cost Control	58%	1.6
4. Labour Force	56%	2.0
5. Equipment Maintenance	50%	1.0
6. Exploration	23%	.7
7. Marketing	20%	.7
8. Diversification	18%	.4
9. End Product Devel't	13%	.3

Question 3: **Please rate the following factors in terms of their potential contribution to profitability and rank the top five.**

Ratings - Operations Group

Factors	Percentage Positive Rating	Mean Rating
1. Management	90%	4.5
2. Labour Force	79%	4.2
3. Cost Control	75%	4.1
4. Equipment Maintenance	70%	3.7
5. Technology	55%	3.6
6. Marketing	38%	2.9
7. Exploration	36%	2.9
8. End Product Devel't	18%	2.3
9. Diversification	14%	2.3

Rankings - Operations Group

Factors	Percentage In Top Five	Mean Ranking
1. Management	61%	2.5
2. Labour Force	67%	2.4
3. Cost Control	59%	1.8
4. Equipment Maintenance	53%	1.2
5. Technology	39%	.9
6. Exploration	28%	.5
7. Marketing	25%	.6
8. End Product Devel't	9%	.2
9. Diversification	9%	.2

In Question 4, respondents were asked the level of utilization of state-of-the-art equipment or processes in their operations. Seven percent of the sample indicated it was all state-of-the-art, while 46% said mostly and 45% said some state-of-the-art. Only 2% indicated none or no state-of-the-art equipment or processes.

Question 5 deals with the amount of investment devoted to:

i) repair and maintenance

ii) time tested technology

iii) recent technology

in the past three years (Question 5a) and planned for the next three years (Question 5b). At this point it is important to note that the questionnaires were self-administered and as such there is an element of interpretation on the respondents' part which must be considered. An examination of the responses to Question 5 shows that the respondents had variant interpretations of the wording in this question. It is assumed that each respondent answered Part a) and b) with a consistent understanding regardless of interpretation. This assumption was used to analyze the data in a way that would compensate for the various interpretations and focus on trends rather than absolute numbers.

It was decided to examine the results in terms of the ratios- $\frac{5bi)}{5ai)}$, $\frac{5bii)}{5aii)}$ and $\frac{5biii)}{5aiii)}$ as representing a degree of change. The following provides the results in percentage of respondents:

	Decrease	No Change	Increase
Repair & Maint.	**33%**	**46%**	**21%**
Time-tested Tech.	**48%**	**34%**	**18%**
Recent Tech.	**29%**	**35%**	**36%**

Question 6a) asked about the presence of a formal research and development group within the organization. Fifty-six percent indicated that there was such a group. Of those that indicated the location of this organization/group, 87% said Canada. The second part of the Question asked whether or not the firm has a person or group responsible for technology planning. Forty-seven percent of the sample gave an affirmative response.

While there are no dramatic differences in the responses across groups, the analysis of the subsamples presents some strong variations. Eighty-four percent of the smelter operators and 79% of the respondents in the open-pit subsample indicated the presence of a formal research and development group but only 41% of the underground mines subsample did so.

Question 7a) asks respondents to identify the most recent application or installation of new technology in their operations. The list of installations is diverse with very few duplications. This indicates that either the sample represents a fairly large set of companies or respondents from the same firm had different applications in mind when answering the question. This is important in light of 7b) which asks if the equipment was purchased; developed in house; customized by vendor; or adapted in house. The actual list of installations is included on the following pages.

Executives

Question 7a): What and when was the most recent installation or application of a new process/equipment to your operation?

Cyanidation process employing carbon in leach

Vat leaching of oxide ore (1974)

Monolithic packing on longwall level

Computer controlled mining drills

On stream analysis

Fluxed pellets

Computers

#4 Continuous pickle line

Computerized mine planning

Mechanized scaler

Carbon in pulp process

Polydeck screens

Surface miner for loading thin coal seams

New process for producing sulphate of potash

Microprocesseurs au sechage du minerai

Disk filters

Autogeneous grinding

Fine sieves and spirals in wash plant (1975)

Mucking machine (1977)

Remote control

Executives (Continued)

Question 7a): What and when was the most recent installation or application of a new process/equipment to your operation?

Mill control room

Handling system in fuming plant

Mill flotation process control

Pressure leading of zinc contentrate, jumbo tank refiner

Wet milling

Car door closer

Continuous mining system (1986)

Grinding equipment

Electrostatic separators to remove topaz

Conversion of Cu refinery cell house

Tunnel boring

Mill automation

Conveyor belt with tilting station

Electrical/hydraulic jumbos

Slag cleaning

Automate programmable

Researchers

Question 7a): What and when was the most recent installation or application of a new process/equipment to your operation?

Continuous loader and remote control truck

CEZ

Magnetic upgrading of ilmenite ore

Stainless steel cathodes in copper refinery (1986)

Pilot processing plant (1986)

Reliance electrical wheel system (1986)

Process control equipment

Grinding control software (1979)

New process plant

Hydraulic backfill

Hydraulic hoist

Carbon alumno

Jumbo hydrauliques

Electrical hydraulic jumbos

Scaler, blockholer

Automate programmable

Leaching of ore as a mining method (1984)

Waste dump leach

Micro-seismic monitoring sytems

Mechanized scaling machine

Train load out computing system

Milling process Denver flotation cells

Zinc pressure leaching and new zinc tankroom

Monolithic packing

Operations

Question 7a): What and when was the most recent installation or application of a new process/equipment to your operation?

Modified plant circuitry and new weigh system for packaged product

On board computer for shovel dipper load weighing

Drum filter

Semi-portable in-pit crusher/conveyor system

Central dispatch system

Rock mechanics

Hydraulic backfill machine

Low profile raise boring machine (1976)

On stream analyzer (1986)

Replacement of process control computer

Computerization, backfill technology, ground support (1985)

Ensachage automatique

Moulin il'y a plus de 20 ans!

Process control equipment

New flotation cells

Spiral concentrators (1983)

Construction of new plant (1982)

Continuous casting (under construction - 1987)

Micro-seismic monitor

Operations (Continued)

Question 7a): What and when was the most recent installation or application of a new process/equipment to your operation?

Vacuum dezincing of lead metal

Alkaline chlorination and SO_2/air

New wash plant

Micro-processor control of final product tripper car

Process control system

Mill modernization

32 cubic meter flotation cells

Underground radio communications

Magnetic separators/circuit redesign

Process control computer

Electric hydraulic drill

Baulloire electrique 12MW

Column flotation

Ramp haulage and hydraulic drilling

Rockbreaker

Microcomputers, large loader and grader

Waste handling system

Bailey network 90 control system

Flux iron ore pellets (1985) - developed in-house

Conccetration d'or avec SAG et CIP

Continuous loaders

Operations (Continued)

Question 7a): What and when was the most recent installation or application of a new process/equipment to your operation?

Computerized dispatch and mine operations control

Flux pellet plant (1986) - customized by vendor

Yttrium plant

Microprocessor for major conveyor drive underground

Pulverized coal fired coal drier

Long boom dragline

Water treatment plants

New underground loaders

Cyanide scavenger circuit for flotation tailoring

New beneficiation circuitry

Fifty-four percent of the respondents to Question 7 indicated that the most recent installation or application of a new process or equipment to their operation was in 1985. Twenty-six percent indicated the period between 1980-1984. Two respondents wrote that the last application was 1965, and another in 1975. Eighteen percent marked 1986.

The results of Question 7b) are:

Purchased	**36%**
Purchased & Customized by Vendor	**19%**
Adapted In-House	**7%**
Purchased & Adapted In-House	**11%**
Combination Purch. & Developed In-house	**6%**
Developed In-House	**13%**
Combination of All	**8%**

Fifty-five percent are pure purchases, while another 18% are putting value-added work into the purchased goods. Only 13% are developed solely in-house.

Question 7c) asks who or what group in the organization identified the need for the recent application. The results:

Groups:	Exec.	Res.	Oper.	Total	%
Executive	11	4	5	20	14%
Research/Engineering/Technical	15	13	15	43	29%
Operating Management & Staff	21	19	31	71	48%
Combination	6	1	3	10	7%
External (Gov't & Consultants)	1	0	2	3	2%

The responses to part d) regarding who or what group in the organization was responsible for finding the appropriate technology shows that it is common practice among respondents for those that identified the need to also be charged with finding the solutions. In seventy-four percent of the cases this is true. In fifteen percent the need was identified by Operations and the Engineering/Research group was responsible for finding the technology. In 10% the flow went from the Executive group to the Research group. The remaining1% went from Executives to Consultants or other external groups.

When asked who or what group in the organization presented the project to the executive for the decision to implement the technology, in 61% of the cases the same group or person who identified the need was charged with making the presentation. In 48% of the cases the answers to parts c), d), and e) of Question 7 are the same. In other words, he/she who identifies the need also finds the technology and then presents the project to the executive for approval.

Factors influencing the decision to implement most frequently include, not surprisingly, Cost Savings and Productivity Improvements. The full results are provided in the next chart.

Question 7f): What three major factors influenced the decision to implement?

FACTORS	Total(%)	Exec.(%)	Res.(%)	Oper.(%)
Cost Savings	93(53%)	37(61%)	18(41%)	38(54%)
Product Quality	23(13%)	11(18%)	5(11%)	7(10%)
Return on Investment	20(11%)	9(15%)	2(4%)	9(13%)
Increased Recovery	21(12%)	9(15%)	5(11%)	7(10%)
Market	21(12%)	11(18%)	4(9%)	6(8%)
Health and Safety	23(13%)	9(15%)	6(14%)	8(11%)
Pollution Control	15(8%)	5(8%)	4(9%)	6(8%)
Profitability	9(5%)	7(11%)	2(4%)	0(---)
Productivity Imp.	67(38%)	12(20%)	22(50%)	33(47%)
Labour Savings	11(6%)	4(6%)	3(7%)	4(6%)
Energy Conservation	9(5%)	2(3%)	3 (7%)	4(6%)
Orebody	11(6%)	4(6%)	2(4%)	5(7%)
Long Term Benefits	26(15%)	3(5%)	6(14%)	17(24%)
Gov't Assistance	3(2%)	0(---)	3(7%)	0(---)
Increased Reliability	10(6%)	3(5%)	1(2%)	6(8%)
Outdated Equipment	4(2%)	1(2%)	0(---)	3(4%)
Proven Technology	5(3%)	0(---)	3(7%)	2(3%)

Section C: Information Sources

This section focusses on sources of information about new technology. Question 8 lists sixteen possible sources and asks the respondents to indicate which ones they currently use and rate their value. In-House Expertise was rated highly (73%) in terms of value but falls behind Trade Publications, Personal Contacts in Industry, Visits to Other Canadian Firms and Suppliers in usage.

There are some interesting differences in the value the three groups place on certain sources. Consultants rate as high value sources for 66% of the Executive group but only 40% of the Research and 40% of Operations groups gave Consultants a positive rating. Government Departments is another source that elicited significantly different values from the various groups. While only 24% of the Executive group and 22% of the Research group rated it highly, none of the Operations group gave it a value above 3, which on a scale of 1-5 registers as non-commitment.

Sources of Information - Usage

Sources	Total	Executives	Research	Operations
1. Trade Journals	98%	100%	100%	95%
2. Personal Contacts	89%	84%	95%	89%
3. Visits to Cdn. Firms	84%	84%	92%	77%
4. Suppliers	82%	80%	82%	84%
5. In-house Expertise	81%	82%	84%	77%
6. Newsletters & Bulletins	80%	82%	79%	79%
7. Consultants	74%	71%	76%	74%
8. Seminars, Conf., Courses	72%	66%	84%	70%
9. Ind. & Prof. Associations	59%	66%	58%	53%
10. Visits to Foreign Firms	58%	73%	55%	47%
11. Exhibits & Shows	57%	55%	68%	52%
12. Colleges & Universities	48%	54%	58%	39%
13. Prov. Res. & Tech.Centres	47%	54%	47%	41%
14. Government Labs.	44%	43%	66%	33%
15. Government Departments	41%	41%	58%	33%
16. Bus.& Tech. Databases	30%	29%	37%	26%

Sources of Information - Ratings

Source	Total%(M)	Exec.%(M)	Res.%(M)	Ops.%(M)
1. In-House Expertise	73% (4.0)	70%(3.9)	76%(4.0)	74%(4.0)
2. Personal Contacts	70% (3.9)	71% (3.9)	73%(4.0)	67%(3.8)
3. Trade Journals	67%(3.9)	64%(3.8)	67%(3.8)	68%(4.0)
4. Visits to Cdn. firms	54%(3.6)	52%(3.5)	55%(3.6)	57%(3.7)
5. Suppliers	48%(3.4)	40%(3.6)	36%(3.3)	52%(3.4)
6. Consultants	48%(3.3)	66%(3.7)	40%(3.1)	40%(3.2)
7. Seminars,Confs. etc.	46%(3.3)	49%(3.1)	60%(3.4)	47%(3.3)
8. Visits, Foreign Firms	45%(3.1)	49%(3.4)	52%(3.2)	37%(2.9)
9. Newsletters &Bulletins	36%(3.2)	41%(3.3)	33%(3.0)	35%(3.2)
10. Ind.&Prof. Associations	34%(2.9)	37%(3.1)	27%(2.8)	36%(2.9)
11. Exhibits & Shows	25%(2.8)	29%(3.0)	29%(2.8)	18%(2.7)
12. Bus. & Tech. Databases	24%(2.4)	33%(2.6)	30%(2.7)	13%(2.2)
13. Government Labs.	23%(2.6)	19%(2.6)	34%(3.0)	17%(2.2)
14. Prov. Research &Tech.	19%(2.3)	26%(2.6)	20%(2.3)	11%(2.0)
15. Colleges & Universities	16%(2.4)	16%(2.4)	20%(2.7)	14%(2.3)
16. Government Departments	15%(2.4)	24%(2.6)	22%(2.6)	--(--)

Section D: Constraints & Barriers

This section was designed to gather information on the mining industry's perception of contraints and barriers to the application of technology. The questions centre around human resource, technical and economic factors which may represent barriers to the introduction of new technologies. The respondents were asked to both rate and rank these three sets of factors.

Human Resource Factors

The most highly rated human resource factor in terms of representing a major constraint to the implementation of new technology was Lack of In-House Expertise (27%). This was closely followed by:

Management Attitude	(26%)
Availability of Required Skills	(26%)
Identifying Appropriate Outside Expertise	(24%)

Within each group however, the top three human resource barriers in terms of ratings were somewhat different. The Executive group results were:

Management Attitude	(30%)
Lack of In-House Expertise	(30%)
Identifying Appropriate Outside Expertise	(27%).

The Research group identified:

Management Attitude	(35%)
Availability of Required Skills	(31%)
Corporate Structure	(23%).

Operations:

Lack of In-House Expertise	(27%)
Identifying Appropriate Outside Expertise	(24%)
Availability of Required Skills	(24%)

The rankings assigned by the three groups to the human resource factors was not inconsistent with their ratings and incorporate the same cross-group differences.

Technical Factors

The most highly rated technical barrier to the application to technology was Risk Involved in Applying Unproven Technology (66%). This is followed by Retrofit Problems (42%) and Difficulty in Modifying Available Technology (35%).

Economic Factors

The foremost economic barriers were Cash Availability (73%), Financing Support (53%) and Difficulty in Forecasting International Economic Activity (52%). Results of the aggregate ranking were similar and were relatively consistent across groups.

Question 9: **To what degree do the following human resource factors represent restraints/ barriers to the implementation of new technology in your operation(s)? Also, please rank the top three.**

Results -Total Sample

Human Resource Factors	Percentage &Mean Positive Ratings	Percentage &Mean Top Three Ranking
1.Lack of In-House Expertise	27%(2.7)	42%(.8)
2. Availability of Skills	26%(2.7)	37%(.7)
3. Management Attitude	26%(2.5)	32% (.7)
4. Identifying External Expertise	24%(2.6)	37%(.8)
5. Employee Attitudes	20%(2.5)	21%(.4)
6. Union Issues	18%(2.1)	21%(.4)
7. Corporate Structure	12%(2.1)	19%(.4)
8. Retraining	12%(2.3)	15%(.3)

Results - Executive Group

Human Resource Factors	Percentage &Mean Positive Ratings	Percentage &Mean Top Three Ranking
1. Lack of In-House Expertise	30%(2.8)	42%(.8)
2. Management Attitude	30%(2.6)	36%(.8)
3. Identifying External Expertise	27%(2.7)	38%(.8)
4. Availability of Skills	25%(2.7)	43%(.7)
5. Employee Attitude	20%(2.5)	21%(.4)
6. Retraining	13%(2.4)	19%(.3)
7. Union Issues	12%(2.0)	19%(.4)
8. Corporate Structure	9%(2.1)	15%(.3)

Question 9: **To what degree do the following human resource factors represent restraints/ barriers to the implementation of new technology in your operation(s)? Also, please rank the top three.**

Results - Research Group

Human Resource Factors	Percentage &Mean Positive Ratings	Percentage &Mean Top Three Ranking
1. Management Attitudes	35%(2.7)	38%(1.0)
2. Availability of Skills	31%(2.8)	40%(.8)
3. Lack of In-House Expertise	23%(2.5)	44%(.8)
4. Corporate Structure	23%(2.2)	20%(.4)
5. Identifying External Expertise	22%(2.6)	37%(.7)
6. Union Issues	20%(2.1)	20%(.4)
7. Employee Attitude	15%(2.3)	12%(.2)
8. Retraining	12%(2.2)	10%(.1)

Results - Operations Group

Human Resource Factors	Percentage &Mean Positive Ratings	Percentage &Mean Top Three Ranking
1. Lack of In-House Expertise	27%(2.8)	37%(.7)
2. Identifying External Expertise	24%(2.5)	36%(.8)
3 Availability of Skills	24%(2.7)	29%(.6)
4. Employee Attitude	23%(2.5)	20%(.4)
5. Union Issues	21%(2.3)	25%(.5)
6. Management Attitudes	15%(2.1)	24%(.4)
7. Retraining	10%(2.3)	15%(.3)
8. Corporate Structure	8%(2.0)	23%(.4)

Question 10: Please rate the following technical factors as to the degree they represent barriers/constraints to the application of new technology in your operations. Please rank the top three.

Results - Total Sample

Technical Factors	Percentage &Mean Positive Ratings	Percentage &Mean Top Three Ranking
1. Risk Involved	66%(3.8)	65%(1.7)
2. Retrofit Problems	42%(3.1)	47%(1.0)
3. Modifying Avail. Technology	35%(3.0)	47% (.8)
4. Opt. Future Flexibility	26%(2.7)	31% (.5)
5. Inadequate Information	20%(2.6)	36% (.6)

Results - Executive Group

Technical Factors	Percentage &Mean Positive Ratings	Percentage &Mean Top Three Ranking
1. Risk Involved	72%(4.1)	78%(2.0)
2. Retrofit Problems	46%(3.2)	56%(1.3)
3. Modifying Avail. Technology	40%(3.1)	51%(.7)
4. Opt. Future Flexibility	21%(2.5)	33%(.6)
5. Inadequate Information	20%(2.5)	44%(.8)

Question 10: Please rate the following technical factors as to the degree they represent barriers/constraints to the application of new technology in your operations. Please rank the top three.

Results - Research Group

Technical Factors	Percentage &Mean Positive Ratings	Percentage &Mean Top Three Ranking
1. Risk Involved	69%(3.9)	67%(1.8)
2. Retrofit Problems	41%(3.0)	46% (.8)
3. Modifying Avail. Technology	37%(3.1)	61%(1.0)
4. Opt. Future Flexibility	23%(2.8)	28% (.5)
5. Inadequate Information	21%(2.5)	35% (.7)

Results - Operations Group

Technical Factors	Percentage &Mean Positive Ratings	Percentage &Mean Top Three Ranking
1. Risk Involved	58%(3.6)	52%(1.4)
2. Retrofit Problems	40%(3.1)	41% (.8)
3. Opt. Future Flexibility	32%(2.7)	30% (.5)
4. Modifying Avail. Technology	29%(2.9)	34% (.7)
5. Inadequate Information	18%(2.6)	30% (.4)

Question 11: Please indicate the degree that the following economic factors represent barriers/constraints to the introduction of new technology in your operation(s). Please rank the top three.

Result - Total Sample

Economic Factors	Percentage&Mean Positive Ratings	Percentage&Mean Top Three Ranking
1. Cash Availability	73%(3.9)	58%(1.5)
2. Financing Support	53%(3.4)	37%(.7)
3. International Economics	52%(3.4)	42%(.8)
4. Hidden Costs	43%(3.2)	33%(.6)
5. Rising Fixed Costs	40%(3.1)	28%(.5)
6. Unknown Benefits	38%(3.1)	29%(.6)
7. Existing Costs Unavail.	25%(2.5)	17%(.2)
8. Duties & Tariffs	6%(1.9)	5%(.1)

Result - Executive Group

Economic Factors	Percentage&Mean Positive Ratings	Percentage&Mean Top Three Ranking
1. Cash Availability	68%(3.8)	65%(1.7)
2. International Economics	51%(3.4)	40%(.6)
3. Hidden Costs	50%(3.3)	44%(.9)
4. Financing Support	45%(3.2)	36%(.6)
5. Unknown Benefits	43%(3.2)	33%(.6)
6. Rising Fixed Costs	37%(3.0)	35%(.5)
7. Existing Costs Unavail.	27%(2.5)	21%(.3)
8. Duties & Tariffs	10%(1.8)	4%(.1)

Question 11: Please indicate the degree that the following economic factors represent barriers/constraints to the introduction of new technology in your operation(s). Please rank the top three.

Result - Research Group

Economic Factors	Percentage&Mean Positive Ratings	Percentage&Mean Top Three Ranking
1. Cash Availability	71%(4.0)	54%(1.2)
2. Financing Support	64%(3.6)	25%(.5)
3. International Economics	50%(3.3)	50%(1.0)
4. Hidden Costs	49%(3.3)	31%(.6)
5. Rising Fixed Costs	45%(3.2)	29%(.6)
6. Unknown Benefits	42%(3.2)	68%(.7)
7. Existing Costs Unavailable	21%(2.5)	18%(.3)
8. Duties & Tariffs	5%(1.8)	8%(.1)

Result - Operations Group

Economic Factors	Percentage&Mean Positive Ratings	Percentage&Mean Top Three Ranking
1. Cash Availability	77%(4.0)	55%(1.4)
2. International Economics	55%(3.4)	39%(.8)
3. Financing Support	54%(3.4)	44%(.8)
4. Rising Fixed Costs	39%(3.1)	23%(.4)
5. Hidden Costs	34%(3.1)	22%(.4)
6. Unknown Benefits	30%(2.9)	22%(.4)
7. Existing Costs Unavailable	25%(2.5)	12%(.2)
8. Duties & Tariffs	2%(2.0)	4%(--)

Section E: Government Programs

This section involves the awareness, usage and influence of government programs on the respondents. It also addresses participation in joint venture or co-operative research and development efforts.

In Question12, respondents were asked to indicate which of four tax incentives they were aware of; which the firm had used and whether or not they influenced investment decision. There was a very high level of awareness of tax incentives, ranging from 93% to 70% with R&D Tax Write-offs at the top of the scale. Approximately half of those that indicated awareness of the four incentives had used them. The most used (60%) are the Investment Tax Credits.

Awareness of government programs ranged from 24% for DIPP to 64% for IRDP and 63% for IRAP and CEIC programs. Usage is significantly less than half of those that are aware. Respondents indicated the CEIC programs are the most frequently used 33% and NSERC the least (1%). The Operations group is generally less aware of both incentives and programs than either of the other two groups.

It is clear from the charts that tax incentives have far more influence on investment decisions than do other goverment programs included in the questionnaire. For tax incentives the percentage of respondents that indicated influence ranges from 36% to 18%. This contrasts with a range of 0.7% to 15% for the other government programs.

Question 13 lists eight possible joint venture partners and asked which the firm had co-operated with in the past. The most frequently identified partner was University Laboratories (78%) and the least frequent was Customer and End-Users with 32%. Interestingly, there is only a marginal difference between the number of respondents that indicated Other Mining Companies as R&D partners (60%) and those that had used Government Laboratories (64%).

When asked which of the eight potential partners in R&D initiatives in generic technology would be most attractive, the largest percentage, 32%, said other Canadian Mining Companies. The most adamant group with this view, it seems, is the Research group with 44% indicating Other Canadian Mining Firms. The least attractive partner was Foreign Mining Firms with 5%, followed closely by Customers and End-Users (8%).

TECHNOLOGY IN MINING

BASE: ALL RESPONDENTS

Q.12A AWARENESS, USAGE, AND INFLUENCE OF TAX INCENTIVES ON INVESTMENT DECISIONS

	TOTAL	EXEC.	R&D	OPER-ATION	Q6A R&D GROUP	Q6B TECH. PLAN.	U/G ONLY	OPEN PIT ONLY	MIXED U/G+ OPEN	SMEL-TERS
BASE	177	61	44	70	98	81	56	46	66	63
NO ANSWER	28 15.8%	3 4.9%	7 15.9%	18 25.7%	9 9.2%	10 12.3%	12 21.4%	4 8.7%	10 15.2%	9 14.3%
THOSE WHO ANSWERED (BASE)	149	58	37	52	89	71	44	42	56	54
ACCELERATED CAPITAL COST ALLOWANCES										
AWARE	133 89.3%	57 98.3%	35 94.6%	39 75.0%	82 92.1%	67 94.4%	39 88.6%	38 90.5%	50 89.3%	49 90.7%
USED	87 58.4%	39 67.2%	23 62.2%	24 46.2%	56 62.9%	48 67.6%	17 38.6%	27 64.3%	37 66.1%	33 61.1%
NOT USED	29 19.5%	12 20.7%	6 16.2%	11 21.2%	15 16.9%	8 11.3%	16 36.4%	7 16.7%	6 10.7%	10 18.5%
NOT STATED	17 11.4%	6 10.3%	6 16.2%	4 7.7%	11 12.4%	11 15.5%	6 13.6%	4 9.5%	7 12.5%	6 11.1%
INFLUENCED	52 34.9%	24 41.4%	14 37.8%	14 26.9%	34 38.2%	26 36.6%	8 18.2%	18 42.9%	22 39.3%	22 40.7%
NOT INFLUENCED	36 24.2%	14 24.1%	8 21.6%	14 26.9%	22 24.7%	16 22.5%	15 34.1%	8 19.0%	12 21.4%	14 25.9%
NOT STATED	45 30.2%	19 32.8%	13 35.1%	11 21.2%	26 29.2%	25 35.2%	16 36.4%	12 28.6%	16 28.6%	13 24.1%
NOT AWARE	16 10.7%	1 1.7%	2 5.4%	13 25.0%	7 7.9%	4 5.6%	5 11.4%	4 9.5%	6 10.7%	5 9.3%

BASE: ALL RESPONDENTS

Q.12A AWARENESS, USAGE, AND INFLUENCE OF TAX INCENTIVES ON INVESTMENT DECISIONS

	TOTAL	EXEC.	R&D	OPER-ATION	Q6A R&D GROUP	Q6B TECH. PLAN.	U/G ONLY	OPEN PIT ONLY	MIXED U/G+ OPEN	SMEL-TERS
BASE	177	61	44	70	98	81	56	46	66	63
NO ANSWER	26 14.7%	6 9.8%	5 11.4%	15 21.4%	6 6.1%	10 12.3%	13 23.2%	4 8.7%	7 10.6%	9 14.3%
THOSE WHO ANSWERED (BASE)	151	55	39	55	92	71	43	42	59	54
R&D TAX WRITE-OFFS										
AWARE	140 92.7%	55 100.0%	36 92.3%	47 85.5%	89 96.7%	68 95.8%	40 93.0%	39 92.9%	55 93.2%	52 96.3%
USED	71 47.0%	28 50.9%	20 51.3%	22 40.0%	51 55.4%	41 57.7%	12 27.9%	21 50.0%	34 57.6%	34 63.0%
NOT USED	48 31.8%	21 38.2%	9 23.1%	18 32.7%	23 25.0%	13 18.3%	21 48.8%	14 33.3%	11 18.6%	10 18.5%
NOT STATED	21 13.9%	6 10.9%	7 17.9%	7 12.7%	15 16.3%	14 19.7%	7 16.3%	4 9.5%	10 16.9%	8 14.8%
INFLUENCED	41 27.2%	13 23.6%	13 33.3%	15 27.3%	27 29.3%	23 32.4%	6 14.0%	11 26.2%	22 37.3%	20 37.0%
NOT INFLUENCED	45 29.8%	20 36.4%	10 25.6%	15 27.3%	27 29.3%	17 23.9%	16 37.2%	14 33.3%	13 22.0%	17 31.5%
NOT STATED	54 35.8%	22 40.0%	13 33.3%	17 30.9%	35 38.0%	28 39.4%	18 41.9%	14 33.3%	20 33.9%	15 27.8%
NOT AWARE	11 7.3%	- -%	3 7.7%	8 14.5%	3 3.3%	3 4.2%	3 7.0%	3 7.1%	4 6.8%	2 3.7%

TECHNOLOGY IN MINING

Q.12A AWARENESS, USAGE, AND INFLUENCE OF TAX INCENTIVES ON INVESTMENT DECISIONS

BASE: ALL RESPONDENTS

	TOTAL	EXEC.	R&D	OPER-ATION	Q6A R&D GROUP	Q6B TECH. PLAN.	U/G ONLY	OPEN PIT ONLY	MIXED U/G+ OPEN	SMEL-TERS
BASE	177	61	44	70	98	81	56	46	66	63
NO ANSWER	34 19.2%	7 11.5%	8 18.2%	19 27.1%	11 11.2%	11 13.6%	15 26.8%	4 8.7%	13 19.7%	12 19.0%
THOSE WHO ANSWERED (BASE)	143	54	36	51	87	70	41	42	53	51
CANADIAN DEVELOPMENT EXPENSES (CDE)										
AWARE	100 69.9%	38 70.4%	28 77.8%	33 64.7%	62 71.3%	53 75.7%	31 75.6%	29 69.0%	37 69.8%	34 66.7%
USED	52 36.4%	23 42.6%	11 30.6%	17 33.3%	32 36.8%	29 41.4%	12 29.3%	17 40.5%	21 39.6%	18 35.3%
NOT USED	28 19.6%	9 16.7%	7 19.4%	12 23.5%	16 18.4%	11 15.7%	12 29.3%	9 21.4%	7 13.2%	8 15.7%
NOT STATED	20 14.0%	6 11.1%	10 27.8%	4 7.8%	14 16.1%	13 18.6%	7 17.1%	3 7.1%	9 17.0%	8 15.7%
INFLUENCED	26 18.2%	10 18.5%	7 19.4%	9 17.6%	17 19.5%	13 18.6%	4 9.8%	6 14.3%	15 28.3%	12 23.5%
NOT INFLUENCED	34 23.8%	11 20.4%	9 25.0%	14 27.5%	20 23.0%	17 24.3%	12 29.3%	13 31.0%	8 15.1%	10 19.6%
NOT STATED	40 28.0%	17 31.5%	12 33.3%	10 19.6%	25 28.7%	23 32.9%	15 36.6%	10 23.8%	14 26.4%	12 23.5%
NOT AWARE	43 30.1%	16 29.6%	8 22.2%	18 35.3%	25 28.7%	17 24.3%	10 24.4%	13 31.0%	16 30.2%	17 33.3%

TECHNOLOGY IN MINING

Q.12A AWARENESS, USAGE, AND INFLUENCE OF TAX INCENTIVES ON INVESTMENT DECISIONS

BASE: ALL RESPONDENTS

	TOTAL	EXEC.	R&D	OPER-ATION	Q6A R&D GROUP	Q6B TECH. PLAN.	U/G ONLY	OPEN PIT ONLY	MIXED U/G & OPEN	SMEL-TERS
BASE	177	61	44	70	98	81	56	46	66	63
NO ANSWER	28 15.8%	4 6.6%	6 13.6%	18 25.7%	8 8.2%	9 11.1%	14 25.0%	3 6.5%	9 13.6%	9 14.3%
THOSE WHO ANSWERED (BASE)	149	57	38	52	90	72	42	43	57	54
INVESTMENT TAX CREDITS										
AWARE	135 90.6%	56 98.2%	36 94.7%	42 80.8%	84 93.3%	68 94.4%	38 90.5%	41 95.3%	50 87.7%	50 92.6%
USED	89 59.7%	38 66.7%	23 60.5%	28 53.8%	57 63.3%	43 59.7%	17 40.5%	29 67.4%	38 66.7%	35 64.8%
NOT USED	24 16.1%	11 19.3%	4 10.5%	9 17.3%	15 16.7%	10 13.9%	13 31.0%	7 16.3%	4 7.0%	8 14.8%
NOT STATED	22 14.8%	7 12.3%	9 23.7%	5 9.6%	12 13.3%	15 20.8%	8 19.0%	5 11.6%	8 14.0%	7 13.0%
INFLUENCED	53 35.6%	22 38.6%	15 39.5%	16 30.8%	36 40.0%	27 37.5%	8 19.0%	17 39.5%	25 43.9%	27 50.0%
NOT INFLUENCED	36 24.2%	14 24.6%	8 21.1%	14 26.9%	20 22.2%	14 19.4%	14 33.3%	11 25.6%	10 17.5%	12 22.2%
NOT STATED	46 30.9%	20 35.1%	13 34.2%	12 23.1%	28 31.1%	27 37.5%	16 38.1%	13 30.2%	15 26.3%	11 20.4%
NOT AWARE	14 9.4%	1 1.8%	2 5.3%	10 19.2%	6 6.7%	4 5.6%	4 9.5%	2 4.7%	7 12.3%	4 7.4%

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TECHNOLOGY IN MINING

Q.12B AWARENESS, USAGE, AND INFLUENCE OF GOVERNMENT PROGRAMS ON INVESTMENT DECISIONS

BASE: ALL RESPONDENTS

	TOTAL	EXEC.	R&D	OPER-ATION	Q6A R&D GROUP	Q6B TECH. PLAN.	U/G ONLY	OPEN PIT ONLY	MIXED U/G+ OPEN	SMEL-TERS
BASE	177	61	44	70	98	81	56	46	66	63
NO ANSWER	33 18.6%	6 9.8%	7 15.9%	19 27.1%	12 12.2%	11 13.6%	17 30.4%	3 6.5%	10 15.2%	7 11.1%
THOSE WHO ANSWERED (BASE)	144	55	37	51	86	70	39	43	56	56
INDUSRTIAL & REGIONAL DEVELOPMENT PROGRAM (IRDP)										
AWARE	92 63.9%	40 72.7%	26 70.3%	26 51.0%	57 66.3%	48 68.6%	26 66.7%	28 65.1%	35 62.5%	39 69.6%
USED	17 11.8%	11 20.0%	3 8.1%	3 5.9%	16 18.6%	11 15.7%	3 7.7%	3 7.0%	10 17.9%	12 21.4%
NOT USED	51 35.4%	18 32.7%	15 40.5%	18 35.3%	26 30.2%	22 31.4%	15 38.5%	19 44.2%	15 26.8%	22 39.3%
NOT STATED	24 16.7%	11 20.0%	8 21.6%	5 9.8%	15 17.4%	15 21.4%	8 20.5%	6 14.0%	10 17.9%	5 8.9%
INFLUENCED	14 9.7%	8 14.5%	5 13.5%	1 2.0%	13 15.1%	10 14.3%	4 10.3%	2 4.7%	8 14.3%	10 17.9%
NOT INFLUENCED	33 22.9%	14 25.5%	8 21.6%	11 21.6%	19 22.1%	14 20.0%	6 15.4%	15 34.9%	11 19.6%	13 23.2%
NOT STATED	45 31.2%	18 32.7%	13 35.1%	14 27.5%	25 29.1%	24 34.3%	16 41.0%	11 25.6%	16 28.6%	16 28.6%
NOT AWARE	52 36.1%	15 27.3%	11 29.7%	25 49.0%	29 33.7%	22 31.4%	13 33.3%	15 34.9%	21 37.5%	17 30.4%

TECHNOLOGY IN MINING

BASE: ALL RESPONDENTS

Q.12B AWARENESS, USAGE, AND INFLUENCE OF GOVERNMENT PROGRAMS ON INVESTMENT DECISIONS

	TOTAL	EXEC.	R1D	OPER-ATION	Q6A R&D GROUP	Q6B TECH. PLAN.	U/G ONLY	OPEN PIT ONLY	MIXED U/G+ OPEN	SMEL-TERS
BASE	177	61	44	70	98	81	56	46	66	63
NO ANSWER	35 19.8%	8 13.1%	7 15.9%	19 27.1%	13 13.3%	12 14.8%	18 32.1%	3 6.5%	11 16.7%	7 11.1%
THOSE WHO ANSWERED (BASE)	142	53	37	51	85	69	38	43	55	56
INDUSTRIAL RESEARCH ASSISTANCE PROGRAM (IRAP)										
AWARE	90 63.4%	34 64.2%	30 81.1%	26 51.0%	56 65.9%	45 65.2%	24 63.2%	28 65.1%	34 61.8%	36 67.9%
USED	26 18.3%	6 11.3%	14 37.8%	6 11.8%	23 27.1%	16 23.2%	7 18.4%	4 9.3%	13 23.6%	17 30.4%
NOT USED	45 31.7%	18 34.0%	10 27.0%	17 33.3%	21 24.7%	18 26.1%	11 28.9%	19 44.2%	13 23.6%	18 32.1%
NOT STATED	19 13.4%	10 18.9%	6 16.2%	3 5.9%	12 14.1%	11 15.9%	6 15.8%	5 11.6%	8 14.5%	3 5.4%
INFLUENCED	16 11.3%	4 7.5%	9 24.3%	3 5.9%	13 15.3%	8 11.6%	6 15.8%	2 4.7%	8 14.5%	9 16.1%
NOT INFLUENCED	31 21.8%	14 26.4%	7 18.9%	10 19.6%	16 18.8%	14 20.3%	6 15.8%	15 34.9%	8 14.5%	13 23.2%
NOT STATED	43 30.3%	16 30.2%	14 37.8%	13 25.5%	27 31.8%	23 33.3%	12 31.6%	11 25.6%	18 32.7%	16 28.6%
NOT AWARE	52 36.6%	19 35.8%	7 18.9%	25 49.0%	29 34.1%	24 34.8%	14 36.8%	15 34.9%	21 38.2%	18 32.1%

TECHNOLOGY IN MINING

Q.12B AWARENESS, USAGE, AND INFLUENCE OF GOVERNMENT PROGRAMS ON INVESTMENT DECISIONS

BASE: ALL RESPONDENTS

	TOTAL	EXEC.	R&D	OPER-ATION	Q6A R&D GROUP	Q6B TECH. PLAN.	U/G ONLY	OPEN PIT ONLY	MIXED U/G+ OPEN	SMEL-TERS
BASE	177	61	44	70	90	81	56	46	66	63
NO ANSWER	41 23.2%	14 23.0%	8 18.2%	18 25.7%	19 19.4%	17 21.0%	19 33.9%	5 10.9%	14 21.2%	12 19.0%
THOSE WHO ANSWERED (BASE)	136	47	36	52	79	64	37	41	52	51
UNSOLICITED PROPOSALS (U.P.)										
AWARE	65 47.8%	22 46.8%	25 69.4%	18 34.6%	41 51.9%	35 54.7%	20 54.1%	18 43.9%	25 48.1%	28 54.9%
USED	31 22.8%	12 25.5%	12 33.3%	7 13.5%	24 30.4%	20 31.2%	10 27.0%	6 14.6%	14 26.9%	19 37.3%
NOT USED	23 16.9%	7 14.9%	8 22.2%	8 15.4%	13 16.5%	11 17.2%	6 16.2%	10 24.4%	6 11.5%	8 15.7%
NOT STATED	11 8.1%	3 6.4%	5 13.9%	3 5.8%	4 5.1%	4 6.3%	4 10.8%	2 4.9%	5 9.6%	1 2.0%
INFLUENCED	20 14.7%	7 14.9%	6 16.7%	7 13.5%	14 17.7%	10 15.6%	8 21.6%	5 12.2%	7 13.5%	12 23.5%
NOT INFLUENCED	19 14.0%	7 14.9%	6 16.7%	6 11.5%	10 12.7%	10 15.6%	5 13.5%	9 22.0%	4 7.7%	5 9.8%
NOT STATED	26 19.1%	8 17.0%	13 36.1%	5 9.6%	17 21.5%	15 23.4%	7 18.9%	4 9.8%	14 26.9%	11 21.6%
NOT AWARE	71 52.2%	25 53.2%	11 30.6%	34 65.4%	38 48.1%	29 45.3%	17 45.9%	23 56.1%	27 51.9%	23 45.1%

BASE: ALL RESPONDENTS

Q.12B AWARENESS, USAGE, AND INFLUENCE OF GOVERNMENT PROGRAMS ON INVESTMENT DECISIONS

	TOTAL	EXEC.	R&D	OPER-ATION	Q6A R&D GROUP	Q6B TECH. PLAN.	U/G ONLY	OPEN PIT ONLY	MIXED U/G+ OPEN	SMEL-TERS
BASE	177	61	44	70	90	81	56	46	66	63
NO ANSWER	37 20.9%	10 16.4%	8 18.2%	18 25.7%	16 16.3%	14 17.3%	19 33.9%	3 6.5%	11 16.7%	10 15.9%
THOSE WHO ANSWERED (BASE)	140	51	36	52	82	67	37	43	55	53
PROGRAM FOR INDUSTRY/LABORATORY PROJECTS (PILP)										
AWARE	62 44.3%	20 39.2%	24 66.7%	18 34.6%	42 51.2%	38 56.7%	13 35.1%	16 37.2%	31 56.4%	27 50.9%
USED	19 13.6%	6 11.8%	9 25.0%	4 7.7%	14 17.1%	15 22.4%	3 8.1%	4 9.3%	12 21.8%	10 18.9%
NOT USED	31 22.1%	11 21.6%	8 22.2%	12 23.1%	19 23.2%	16 23.9%	8 21.6%	10 23.3%	11 20.0%	12 22.6%
NOT STATED	12 8.6%	3 5.9%	7 19.4%	2 3.8%	9 11.0%	7 10.4%	2 5.4%	2 4.7%	8 14.5%	5 9.4%
INFLUENCED	11 7.9%	2 3.9%	7 19.4%	2 3.8%	8 9.8%	9 13.4%	2 5.4%	2 4.7%	7 12.7%	5 9.4%
NOT INFLUENCED	23 16.4%	9 17.6%	5 13.9%	9 17.3%	13 15.9%	12 17.9%	5 13.5%	7 16.3%	10 18.2%	8 15.1%
NOT STATED	28 20.0%	9 17.6%	12 33.3%	7 13.5%	21 25.6%	17 25.4%	6 16.2%	7 16.3%	14 25.5%	14 26.4%
NOT AWARE	78 55.7%	31 60.8%	12 33.3%	34 65.4%	40 48.8%	29 43.3%	24 64.9%	27 62.8%	24 43.6%	26 49.1%

TECHNOLOGY IN MINING

BASE: ALL RESPONDENTS

Q.12B AWARENESS, USAGE, AND INFLUENCE OF GOVERNMENT PROGRAMS ON INVESTMENT DECISIONS

	TOTAL	EXEC.	R&D	OPER-ATION	D6A R&D GROUP	D&B TECH. PLAN.	U/G ONLY	OPEN PIT ONLY	MIXED U/G+ OPEN	SMEL-TERS
BASE	177	61	44	70	98	81	56	46	66	63
NO ANSWER	39 22.0%	10 16.4%	9 20.5%	19 27.1%	15 15.3%	15 18.5%	20 35.7%	3 6.5%	12 18.2%	9 14.3%
THOSE WHO ANSWERED (BASE)	138	51	35	51	83	66	36	43	54	54
DEFENCE INDUSTRY PRODUCTIVITY PROGRAM (DIPP)										
AWARE	33 23.9%	13 25.5%	10 28.6%	10 19.6%	23 27.7%	18 27.3%	10 27.8%	12 27.9%	10 18.5%	14 25.9%
USED	2 1.4%	1 2.0%	1 2.9%	- -%	2 2.4%	1 1.5%	- -%	- -%	2 3.7%	2 3.7%
NOT USED	24 17.4%	7 13.7%	9 25.7%	8 15.7%	15 18.1%	13 19.7%	7 19.4%	10 23.3%	6 11.1%	9 16.7%
NOT STATED	7 5.1%	5 9.8%	- -%	2 3.9%	6 7.2%	4 6.1%	3 8.3%	2 4.7%	2 3.7%	3 5.6%
INFLUENCED	1 .7%	1 2.0%	- -%	- -%	1 1.2%	1 1.5%	- -%	- -%	1 1.9%	1 1.9%
NOT INFLUENCED	18 13.0%	6 11.8%	5 14.3%	7 13.7%	11 13.3%	10 15.2%	6 16.7%	7 16.3%	4 7.4%	5 9.3%
NOT STATED	14 10.1%	6 11.8%	5 14.3%	3 5.9%	11 13.3%	7 10.6%	4 11.1%	5 11.6%	5 9.3%	8 14.8%
NOT AWARE	105 76.1%	38 74.5%	25 71.4%	41 80.4%	60 72.3%	48 72.7%	26 72.2%	31 72.1%	44 81.5%	40 74.1%

TECHNOLOGY IN MINING

Q.12B AWARENESS, USAGE, AND INFLUENCE OF GOVERNMENT PROGRAMS ON INVESTMENT DECISIONS

BASE: ALL RESPONDENTS

	TOTAL	EXEC.	R&D	OPER-ATION	Q6A R&D GROUP	Q6B TECH. PLAN.	U/G ONLY	OPEN PIT ONLY	MIXED U/G+ OPEN	SMEL-TERS
BASE	177	61	44	70	98	81	56	46	66	63
NO ANSWER	34 19.2%	8 13.1%	7 15.9%	18 25.7%	13 13.3%	15 18.5%	17 30.4%	4 8.7%	11 16.7%	10 15.9%
THOSE WHO ANSWERED (BASE)	143	53	37	52	85	66	39	42	55	53
NATURAL SCIENCES & ENGINEERING RESEARCH COUNCIL PROGRAMS (NSERC)										
AWARE	68 47.6%	26 49.1%	27 73.0%	15 28.8%	44 51.8%	39 59.1%	18 46.2%	19 45.2%	27 49.1%	30 56.6%
USED	16 11.2%	4 7.5%	7 18.9%	5 9.6%	15 17.6%	13 19.7%	4 10.3%	5 11.9%	5 9.1%	11 20.8%
NOT USED	32 22.4%	13 24.5%	12 32.4%	7 13.5%	16 18.8%	15 22.7%	9 23.1%	10 23.8%	11 20.0%	13 24.5%
NOT STATED	20 14.0%	9 17.0%	8 21.6%	3 5.8%	13 15.3%	11 16.7%	5 12.8%	4 9.5%	11 20.0%	6 11.3%
INFLUENCED	6 4.2%	2 3.8%	2 5.4%	2 3.8%	6 7.1%	6 9.1%	1 2.6%	3 7.1%	2 3.6%	6 11.3%
NOT INFLUENCED	23 16.1%	11 20.8%	7 18.9%	5 9.6%	13 15.3%	12 18.2%	6 15.4%	9 21.4%	6 10.9%	8 15.1%
NOT STATED	39 27.3%	13 24.5%	18 48.6%	8 15.4%	25 29.4%	21 31.8%	11 28.2%	7 16.7%	19 34.5%	16 30.2%
NOT AWARE	75 52.4%	27 50.9%	10 27.0%	37 71.2%	41 48.2%	27 40.9%	21 53.8%	23 54.8%	28 50.9%	23 43.4%

TECHNOLOGY IN MINING

Q.12B AWARENESS, USAGE, AND INFLUENCE OF GOVERNMENT PROGRAMS ON INVESTMENT DECISIONS

BASE: ALL RESPONDENTS

	TOTAL	EXEC.	R&D	OPER-ATION	Q6A R&D GROUP	Q6B TECH. PLAN.	U/G ONLY	OPEN PIT ONLY	MIXED U/G+ OPEN	SMEL-TERS
BASE	177	61	44	70	98	81	56	46	66	63
NO ANSWER	36 20.3%	6 9.8%	10 22.7%	19 27.1%	15 15.3%	16 19.8%	17 30.4%	5 10.9%	11 16.7%	11 17.5%
THOSE WHO ANSWERED (BASE)	141	55	34	51	83	65	39	41	55	52
CANADA EMPLOYMENT & IMMIGRATION COMMISSION PROGRAMS (CEIC)										
AWARE	89 63.1%	35 63.6%	21 61.8%	32 62.7%	51 61.4%	37 56.9%	26 66.7%	27 65.9%	33 60.0%	35 67.3%
USED	46 32.6%	20 36.4%	11 32.4%	15 29.4%	26 31.3%	20 30.8%	14 35.9%	13 31.7%	18 32.7%	24 46.2%
NOT USED	30 21.3%	9 16.4%	6 17.6%	14 27.5%	16 19.3%	13 20.0%	9 23.1%	11 26.8%	8 14.5%	10 19.2%
NOT STATED	13 9.2%	6 10.9%	4 11.8%	3 5.9%	9 10.8%	4 6.2%	3 7.7%	3 7.3%	7 12.7%	1 1.9%
INFLUENCED	18 12.8%	6 10.9%	7 20.6%	5 9.8%	10 12.0%	5 7.7%	6 15.4%	3 7.3%	8 14.5%	10 19.2%
NOT INFLUENCED	39 27.7%	15 27.3%	6 17.6%	17 33.3%	21 25.3%	18 27.7%	10 25.6%	19 46.3%	10 18.2%	13 25.0%
NOT STATED	32 22.7%	14 25.5%	8 23.5%	10 19.6%	20 24.1%	14 21.5%	10 25.6%	5 12.2%	15 27.3%	12 23.1%
NOT AWARE	52 36.9%	20 36.4%	13 38.2%	19 37.3%	32 38.6%	28 43.1%	13 33.3%	14 34.1%	22 40.0%	17 32.7%

Section F: Opinions and Suggestions

This section of the questionnaire was devoted to open ended questions soliciting opinions and suggestions from respondents on:

A) the unique challenges for the mining industry

B) government programs to stimulate R&D

C) major barriers to technology diffusion

D) actions to further assist development and diffusion

E) the role of various players in R&D.

Some of the responses by group are provided on the following pages for the readers' perusal.

Question 15. Please comment briefly on your opinions and suggestions regarding:

A. The unique challenges the mining industry faces in its efforts to innovate.

The most frequently mentioned challenge is depressed markets adversely affecting operating profits and limiting funds available for innovation, at a time when productivity enhancing innovation is crucial. The groups were quite similar in their identification of the challenges.

EXECUTIVES

Question 15. **Please comment briefly on your opinions and suggestions regarding:**

A. **The unique challenges the mining industry faces in its efforts to innovate.**

"Taxation regime; union position regarding new technology and manpower reduction; high transportation costs in Canada and coastal waters; reluctance to take risks and regulatory regime."

" To reduce costs and improve profitability/productivity while fulfilling moral and social obligations regarding employment. This dilemma faces us in competition with Third World countries."

" In this operation's particular case, the main problem is a sustained shortage of cash coupled with limited ore reserves."

" Low commodity prices and excess government intervention."

" Depressed metals prices that because of government restrictions and high taxation and low profits will not allow competition with other world producers who have different rules to work by."

Question 15 A): Executives (Continued)

" Industry still tends to be too secretive and each company wants to develop and guard its own technology."

" The work ethic and the insular attitude to change."

" Falling commodity prices."

" Changing end markets."

" Must be competitive on a world scale as can't affect price."

" Finding applicable technology when we are not set up to develop it. We do try to use state-of-the-art proven technology. Money to attract practical people into R&D."

" The understanding by organized labour of the need to increase productivity and their willingness to collaborate in effective solutions."

" Depressed product prices. Declining ore reserves. Rising production costs. Deeper mining. Heavy debt burdens - milking funds for re-investment."

Question 15 A): Executives (Continued)

"1) Very capital intensive
2) Commodity product and prices
3) Excess product supply which is being subsidized by various government agencies."

" Improved productivity, new management techniques involving employee throughout operations."

" The major problem faced by the mining industry is the current cash squeeze induced by low metal and mineral prices."

" Labour costs and the cost of capital must be greatly reduced. Can private enterprise compete efficiently in an international environment dominated by non-commercial government agencies?"

" Funding of R&D efforts, limited market for innovations in equipment design."

" Payback period of new investment."

" Continuing low commodity value predicates against investment in technology."

Question 15 A): Executives (Continued)

"Production pressures inhibit formal R&D as priority is low. Major technology demonstrations for equipment or systems is too expensive. Resources in government R&D departments are effectively inaccessible."

" The rapid shifts in the international marketplace - structural changes particularly."

" The type and make-up of individuals attracted to the mining industry."

"1) Transportation - we cannot compete in the long term oversupply world maket without substantial reduction in costs (ie. low rail rate/ pipeline alternative)
2) Alternate use - through liquification, co-processing - displacement of natural gas in EDR/Refining industry in Western Canada.
3) Lower costs of high quality, quality through upgrading of low rank coals."

" Poor markets and prices"

" Cyclical income and ever rising taxes on pre-profit income are strangling the industry as it cannot capitalize more modernization nor its own perpetuation."

Question 15 A): Executives (Continued)

" A lack of capital funds and high loan position of the industry in general."

" Underground environment. High cost and time required to develop new equipment, high debt burden."

" No limit on innovation possible if funding and capital was available."

" The industry needs to increase co-operative research on a national basis."

" Large existing investment in equipment. Need to maintain cash flow in face of low commodity prices."

" We must follow metal prices, we cannot set them."

" Improve productivity per man shift. Lessen constraints and burden imposed by the intervention, rules and regulations imposed by the many government agencies."

" Depressed markets and shortage of capital - particularly for existing operations."

RESEARCHERS

Question 15. Please comment briefly on your opinions and suggestions regarding:

A. The unique challenges the mining industry faces in its efforts to innovate.

"Lower mine/mill cost of production by more at the face preparation of mill feed. This will allow lower grade ore bodies to be economic."

"A group effort is required either through CANMET, MAC, or a newly formed Canadian Mining Research Association to direct research and distribute costs."

"Trouble in dealing with underground environment with the use of electronics etc. Environmental developments are originally created by economic situations on surface, not underground where the needs exist earlier."

"The biggest challenge is persuading senior management to take that leap of faith required in order to institute not completely proven new technology."

Question 15 A): Researchers (Continued)

"Once located, ore has to be removed from the ground. Mining has to deal with this fundamental operation; improvements in the approach can be made with better equipment and methods. The mining industry should devote efforts to improve methods and equipment."

"Capital investment by the mining industry is severely limited by poor equity financing market and real dollar declines in primary metal prices."

"World market conditions."

"Foreign competition."

"More mechanization and automation"

"Lower employment levels in northern and/or company towns."

"Funding. It is time for operations staff to do more innovative work in terms of R&D."

"High taxes - should be reduced. Transportation costs too high. Union activity."

"Underground environment, dust, damp, lighting."

Question 15 A): Researchers (Continued)

"Providing funds for meaningful technology exchange through travel and funding of higher risk development programs."

"No cash but must spend cash to innovate and improve."

"Affordable amounts of personnel"

" Supply/demand - with mineral industry reducing in size, commodities are becoming more expensive to the industry. The challenge is to survive."

"High productivity/lower cost to stay in business. Mining cost reduction through use of technology. Better plant recovery."

"With present economic conditions, payback period on any innovations must be short term."

" 1. Lack of cohesive effort jointly as an industry.
2. Implications of failure severe - approach is therefore conservative.
3. Safety is crucial - must be cautious.
4. Lack of emphasis historically on technology - too much fire fighting."

Question 15 A): Researchers (Continued)

" The underground environment requires major modifications and adaptations to existing technology in order that it be appropriate to underground. It is not immediately obvious what modifications are required. The risks in mining and poor prices need conservatism and no one company is able to significantly advance technology."

" To reduce extraction costs in the face of insufficient 'excess' funds for additional capital expense required for innovation. Inability and reluctance to break away from traditional methodology."

"Mainly a matter of mind-set."

"Present status of metal markets and economic conditions leave industry in a postion where it must use main efforts to optimizing bottom line performance. Little money or staff resources for R&D."

" I don't think the challenge is unique - it probably applies to all Canadian industry. Senior management has to be convinced that they have to investigate/instigate change. Change takes time to 'tune-up' - it is not something that should be left until the earnings drop. Too late then."

Question 15 A): Researchers (Continued)

"Large capital investment and poor payback."

"Our biggest challenge is to compete in a diluted market often losing money for four consecutive years."

"High risk in the face of fluctuating commodity prices."

"Heavy taxload. No cash flow, poor balance sheets. Uncertain future regarding commodity prices."

"Non-standardization of needs."

"The climate for accepting innovative activities in mining is not yet present."

"Problem definition, potential solutions, development of the solution to a practical application and implementation of the technology must be in a reasonable (3 years) time frame and an economic incentive must be realized."

"Infrastructure and energy costs limit available funds."

"Due to international competition, it is important at innovation pays for itself quickly. The unknown costs are very high risk factors."

OPERATORS

Question 15. Please comment briefly on your opinions and suggestions regarding:

A. The unique challenges the mining industry faces in its efforts to innovate.

"Changer la mentalité traditionnelle que l'industrie miniére est difficile a moderniser."

"The domestic industry will not survive without innovation and willingness to change."

"Les risques enormes: le marché, les capuces géologiques et terrain (imprévus). Le cout de renouveler les réserves de minerai."

"Labour redeployment and retraining. Effective and efficient use of academic scientific community."

"Extremely competitive international market for raw materials doesn't allow to find sufficient financial resources for innovations."

"Proven mining methods."

Question 15 A): Operations (Continued)

"Distance from the customer -hence need to increase calorific value of coal versus freight component."

"High risk involved in most mines in innovating as a new method employed at other mines might not work anywhere else as each mine is a different situation."

" Must be able to utilize and adapt technologies in other industries."

"The need to be able to see the forest beyond the trees. Pressures of survival in the '80's clouding issues required for the 90's and beyond. The adaptation of hi-tech to the mining environment - particularly underground."

"The overload of government regulation and time required to study and answer proposed legislation and the cost of developing and implementing new technology in the climate of poor profitability."

"To meet offshore competition, innovation needed to decrease production costs and increase productivity."

"Tough economic conditions make capital investment in new technology more difficult to justify. High costs of government contribute to poor current health of mining industry."

Question 15 A): Operations (Continued)

"La mentalite du person nel en place face aux nouveaux developpement."

"The risks associated with new technologies may not be acceptable under current highly competitive market situation."

"Catch 22 - we must innovate to survive competition particularly from LDC's but they pirate the technology."

"The challenge is to survive."

"Cost of setting up research departments, capable of carrying out large in-depth research is beyond means of most mining companies. Need to set up a co-operative facility to research methods, machines and materials."

" Even though the industry is very depressed, it must get out of its problems by positive action and not only 'retrench'."

"Innovation is our only chance for survival."

"Conciliation technologie & resources humaines."

"There are no challenges that are unique to mining except extra taxation."

Question 15 A): Operations (Continued)

"Small number of end users. Cyclical availability of capital. Remote locations."

"Innovation is difficult in most areas due to resistance to change by employees and union."

"The industry is in very bad financial shape and there is little money left for research."

"Difficulties include high construction costs, sales taxes on new equipment. High power costs can also defeat a project. To compete all costs must be cut."

"Funding, tax incentives, skilled people, proven technology."

"As a base metal producer every avenue must be explored in the name of continued improvements to operating efficiency if we are to maintain an edge over other world producers."

"Low metal prices and the generally flat demand for metals mean innovative efforts are required to stay competitive. Cost must come down or remain constant and productivity must improve."

Question 15 A): Operations (Continued)

"Level of taxation and depressed markets are major hinderances along with sometimes unrealistic environmental concerns."

"Due to changes already encountered in the industry we must encourage more rapid innovation."

"1. Nature of mining.
2. Cost of making changes.
3. Organizational resistance to change."

"The scarcity of extra funds to apply to the innovation of new ideas etc. due to depressed economics of metal markets."

Question 15. Please comment briefly on your opinions and suggestions regarding:

B. Improvement to government grant and tax incentive programs to stimulate R&D activities.

On the subject of government programs, there are predictably a number of respondents who encourage the streamlining and simplification of the administrative aspects. Many also noted that tax incentives are of little value for those companies in a non-taxable position. Some of the responses by group follow.

EXECUTIVES

Question 15. Please comment briefly on your opinions and suggestions regarding:

B. Improvement to government grant and tax incentive programs to stimulate R&D activities.

"Being in a non-taxable position, the tax incentives programs have not benefitted this company. It the same for any operation which is in financial trouble. Therefore, grants or any other forms of direct assistance look more attractive."

"Grants and tax incentive programs should be enhanced and more readily obtainable - less red tape!"

"Accelerated depreciation on new developments/equipment."

"Grant programs with no technology or patent rights flowing to government for larger scale costly demonstration programs. Tax incentive programs are the best means of ensuring lower cost projects."

"Government programs should be of lesser importance than a realistic government approach to taxation. Government should cut involvement and spending to allow free enterprise to dictate if we can achieve the efficiency to survive."

Question 15 B): Executives (Continued)

" There should be more contact between the working level in government which reviews research proposals and with industry."

"More substantial tax credits for R&D spending."

"In the case of the Canada-Manitoba Mineral Development Agreement, a combination of industry input in selection of research topics and provincial/regional administration has made the program more useful."

"Reduce the number of programs and allocate the same amount of money in a more co-ordinated manner."

"Industry must necessarily focus on projects with short term payback. Many government programs have longer term focus, or lack focus. Most government grants involve extended arguments about technology ownership and this is a barrier in many cases."

" Grant tax incentives of 100% (Full tax plus the 50% usually paid in taxes) for all R&D expenditures."

"Most mining companies are not paying tax on income because they have no income. Government should lower indirect taxes such as fuel during periods of low prices."

Question 15 B): Executives (Continued)

"Better joint planning (long range) and financing of technology development is required rather than the present mechanism of government side decision making on industry generated proposals. Tax incentives help, but do not drive decision."

" The key is to stimulate - the difficulty is to develop a balance between applied research and longer term payout type research - some way of combining North American spending would be worthwhile."

"Remove much of the 'red tape' involved in applying for and reporting format requirement of various grants. There are to many 'strings attached' to many of the grant programs."

"The bulk of grants are directed to social employment programs in Eastern Canada (none available to assist the hard-pressed Western coal industry). The industry is for the most part unaware of the incentives and programs that are available for R&D."

"The government should withdraw from all but defense related research and stimulate private enterprise and university research by appropriate grants for problems put forward by industry."

Question 15 B): Executives (Continued)

"Provide opportunity to obtain R&D funding by sale of flow through shares with appropriate write-offs similar to those now in place for exploration."

"Whatever they are they must be stable."

"Simplicity"

"Need more grants for generic R&D; tax advantages useless to loss making companies."

"Need to be more specific to mining."

"These programs are quite good now - ability to sell tax credits for research"

"Do provide a positive impetus and should be continued."

"Taxes based on profits not operating profit. Recognize debt load burden on much of industry. R&D is always the first victim of cutbacks/cost reduction programs."

"Should be continued and/or increased. Government should do less and encourage more research for private sector."

Question 15 B): Executives (Continued)

"Governmental actions continue to add new burdens to the mining industry."

"Past programs have not had encouraging results, especially those functioning to tax sheltering."

"The government can always pour more money into these programs but the real problem lies in the fact that Canadian mining equipment, by and large, is produced in branch plants which gives them little incentive or ability to spearhead R&D undertaking."

"Better communication, greatly increased funding; most important -let provinces administer programs."

"Suggest a single program tailored to need of mining industry. There is a multiplicity of programs but they are only partly effective."

RESEARCHERS

Question 15. Please comment briefly on your opinions and suggestions regarding:

B. Improvement to government grant and tax incentive programs to stimulate R&D activities.

"Cut bureaucracy, combine it into one office."

"Grants and tax incentives should be available to maintain and stimulate large R&D programs."

"Good idea if administered properly and fairly - never seen it yet!! Suggest we need more mining types in government and less politicians and bureaucrats making decisions."

" The Canadian national financing of R&D by government is very inadequate and should be increased considerably"

"More funding should be made available, especially during this poor economic period for mining, to make Canadian mining more viable."

"Incentives provided by governments should not be viewed as the sole R&D stimulant. A fairer tax system and less government intervention would work well in a true climate of free enterprise."

Question 15 B): Researchers (Continued)

"More comprehensive R&D work between research institutes and the mining industry (eg. Ontario Research Foundation, AECL, Universities etc.)."

"Not necessary. Government should pay attention to managing Canadian economy and improving climate for industry."

"Scrap all programs which involve government grants and funnel the resultant savings into tax incentives."

"A single Canadian government approach instead of federal/provincial and regional ones, times the several departments involved."

'Make middle and technical management more aware of programs. Funding of short term practical projects versus 'pie in the sky' programs."

"Red tape must be reduced. Time is generally of the essence - government bureaucrats don't understand this."

Question 15 B): Researchers (Continued)

"The criteria of incrementality, a cornerstone of most of the programs dictates that government support is not available unless the project will not proceed without support. This approach prevents large capable companies from using the programs and ends up supporting useless projects done by inept people."

"Reduce taxes overall and forget the grants and eliminate the civil servants. No more complex forms."

"Little is being allocated to provide technology for improvements in efficiencies, cost reductions and real monetary benefits."

"Faster - less paperwork. Industry can do the work before the government has even considered the paper. Therefore, often do without considering government participation."

" Establish large tax breaks for emphasis on technology and innovation in mining."

"Grants: there must be more available to make existing technology work well in the industrial setting. Funding R&D in an academic type setting is possible. Industry, not government or universities has to make the development take place - the government's role is to assist industry to accomplish this."

Question 15 B): Researchers (Continued)

" Cut out flippable credits or monitor programs more closely - much waste perceived. Market development for metals not well addressed."

"Working great in Quebec. Remember the three year tax free program to stimulate mining - it boomed!"

"Currently adequate but consistently underfunded. Design and delivery is good but never enough money for good ideas with high risk."

"Rendre l'acces dus programmes plus facile, moins ardu. Simplifier les demarches administrative et de transmission des renseigments."

"Present R&D tax write off is too small to promote R&D and in most cases is not even worth identifying due to challenges from Revenue Canada. Should increase tax credits and 300-400% (ITC) to attract the attention it deserves."

"A way has to be found to help our industry without jeopardizing our sales to the USA (dumping) !"

"Tax incentives only work if you are taxable. Outright grants offer some hope of stimulating R&D."

Question 15 B): Researchers (Continued)

"'No strings attached' government assistance should be available. Too much red tape and concern about making findings available to the public."

"The sale of R&D credits rather than direct grants may be the most productive route. It gets direct government intervention out of the system."

"Simplify, rationalize and expedite! Tax incentive programs can only realize 'cash' when taxes are paid. Too much paperwork and know-how required for programs. Federal/provincial taxation makes system complicated an unsure for future direction."

"Less paper work!"

" Infrastructure assistance to develop remote areas."

"Access to remote areas requires government participation."

" The government needs to encourage R&D with tax incentives and these should be maintained until the work is put into use."

OPERATIONS

Question 15. **Please comment briefly on your opinions and suggestions regarding:**

B. Improvement to government grant and tax incentive programs to stimulate R&D activities.

"Tax reductions would be greatest long term incentive as would aid in creation of healthy mining industry."

"Need more grass roots involvement to get industry along with federal and provincial governments working together."

"Future expansion of tax rules to allow non-taxable companies to 'sell' related tax benefits to provide immediate financing"

"Need all the help we can get at that end."

"Full discussion between government and industry regarding needs. Willingness of government to support applied R&D - to achieve results which the small operation can apply readily."

"Programs available not well known."

Question 15 B): Operations (Continued)

"C.E.E. is an excellent tax incentive program but should go from spring to spring."

"Greater funding of new technology."

"Should be more applicable to rugged underground conditions."

"The present grants and incentives under the current federal deficit - cutting plans are reasonably adequate - should continue with these."

"It usually seems that government grants are taken advantage of by non-producers or outright frauds."

"Trés important pour partager les risques mais il faut garder un controle efficace our eviter: fraudes, gaspillage, etc."

"Generally too complicated and too many strings attached to government assistance."

"Removal of subsidies to inefficient producers would be the best improvement. This will inspire excellence in development."

"The present grants are reasonably generous."

"Programs directed more toward practical, on-the-job issues."

Question 15 B): Operations (Continued)

"Government personnel should spend more time in the field offering suggestions on improvements and on R&D funds/facilities available."

"Research grants seem to be the only alternative because industry has built up tax losses for last 3-4 years."

"If a company is not making a profit income tax incentives do not help. Sales tax rebates and grants can help."

"Tax incentives should continue, however they are only of value to those that make a profit."

"Tax incentives are of lesser importance to mining companies paying little or no tax. Flow through provisions do help and should be maintained. Grants for R&D activity is important above all."

"Present level is adequate, diffusion of information on various programs could be greatly enhanced."

"Governments have to be cognizant of the fragile nature of the industry and improve tax incentive programs. We require fewer taxes at this stage."

Question 15 B): Operations (Continued)

"Consult with industry as to what should be done and then support those companies who would use and can do the necessary work efficiently."

"The industry must be given tax incentives to allow for the generation of sufficient operating profits to assist with R&D rather than having to depend on government grants."

Question 15. **Please comment briefly on your opinions and suggestions regarding:**

C. The major barriers to technology diffusion in the mining industry.

The most frequently mentioned barrier to technology diffusion outside of cash constraints is the lack of communication and co-operation among mining companies.

EXECUTIVES

Question 15. **Please comment briefly on your opinions and suggestions regarding:**

C. The major barriers to technology diffusion in the mining industry.

" Once an operation is committed to a mining method or milling process, there are some physical and financial constraints which make it virtually impossible to adapt new technology . Major technological improvements are only applicable if one starts a new operation or has vast ore reserves."

" Lack of knowledge of research being conducted."

"Low profits - with poor operating prospects in the future."

"Communication; patent coverage."

"The geographic scatter of mining operations across the country which makes access to technology sources difficult, expensive and time consuming is the major barrier."

"Cash constraints."

"Communications with R&D establishments."

Question 15 C): Researchers (Continued)

"Diffusion is driven by a necessity, a necessity to cut costs, improve recovery, improve productivity etc. When an objective is defined then the development of the technology will follow if it meets a need and can be economically justified. A climate to ensure these needs are met would assist."

"Foreign patents."

"Proprietary arrangements, capital cost, risk."

"Capital cost, risk."

"Lack of co-operation between the various companies. Due to the various laws, there is reluctance to share information that may be considered unlawful (costs)."

"Competitiveness/different processes and mining methods."

"Major differences in industry."

"Unions want to maintain status quo. They resist attempts at productivity improvements. There is no demonstration facility for people to assess new methods and equipment ."

"Competition especially when much of technology development is privately funded."

Question 15 C): Researchers (Continued)

"Lack of strong, central co-ordination of technology. Strong commitment required by top executives to R&D in the mining industry. Need to recognize differences in requirements eg. large and small mines, hardrock and softrock etc."

"Bad management."

"Most decisions have to be made in the context of how much it would cost to change. In many cases, past investment was such that it is just not justifiable to change the technology."

"Lack of contact with the user industries."

"Government agencies should take part in a concentrated effort to change Canadian attitude (we are material suppliers only - so they say!)."

"High capital cost, low commodity prices make for a difficult environment to justify funding new technology."

"Proprietory attitude on the part of industry."

"Enterprises are too small, without the financial resources."

"Isolation of the industry one group from another is a major problem."

RESEARCHERS

Question 15. Please comment briefly on your opinions and suggestions regarding:

C. The major barriers to technology diffusion in the mining industry.

"Not surprisingly, good technology developments become known very rapidly. The minor developments and inventions are more site specific and no matter how well they are publicized, they will remain relatively obscure."

"Each mining area has different problems to stress, making it difficult for consensus."

"Insufficient cross-pollination of ideas by lack of constant good communications and peer scientist/engineers meetings."

"Reluctance of some companies to share information. Need to visit other mining properties more."

"Level of skills available in remote mining areas is limited."

"Secrecy and protection of 'know-how'."

"Tradition and costs."

Question 15 C): Executives (Continued)

"The major barriers are a) to prevent weak P&L statements; b) no one wants to be the leading edge to prove new technology when one is also having P&L problems."

"Proprietory nature of technology in an intensely competitive industry."

"The major barrier is probably the high risk of additional capital into what is already a high risk industry. In addition there is still an attitude problem - if it wasn't invented here it won't work."

"Financing and non-fully developed techniques."

Question 15 C): Executives (Continued)

"The NIH (not invented here) Factor."

"Failure due to inappropriate application makes for biased generalizations as expressed opinions."

"External awareness."

"Lack of people in the mining industry who understand new technology and servicing of electronic equipment in a hostile environment. Durablility of new technology. Inability to accept change. "

"Inertia and resistance from employees. Financial commitments required."

"No real barriers other than funding."

"Some lingering sense of competition but not as much as before the recession."

"Nature of business."

"High capital costs and recent returns on investment arising from depressed metal prices."

Question 15 C): Executives (Continued)

"Lack of scientific engineering sophistication among operations staff. Technological obsolescence among older, senior personnel; no clear-cut need for new technology that is justifiable economically."

"Lack of co-operative approach among industry members."

"The application of new technology usually happens only when economics dictates changes for survival or because 'new' things can be adopted when there is enough margin for error ie. perceived high profitability."

"The mining industry is very conservative. New technologies must be tried and proven prior to acceptance. We cannot afford the time and effort required to fine tune technology."

"1. Fierce competition between companies for both domestic and foreign markets.
2. Cut-backs in federal funding for field demonstration in proof of concept.
3. Diffused and confused array of unco-ordinated efforts across Canada."

"The major barriers are either management attitudes or lack of disposable income."

Question 15 C): Researchers (Continued)

"Short term thinking - especially financial thinking."

"'Not invented here' syndrome. Apparent high cost. A small mine with few people cannot tell a big company bureaucracy how to do their job."

"Government agencies - little is reaching the required area ie. to reduce costs, allow profitable mining of lower grade deposits."

"Need for technology centres to have business development managers or vice presidents."

"Geographical distance from mining regions to major information centres, libraries, universities, etc. "

"1. Historically, personnel in technology division have been poor 'salespersons' and do not address operations needs.
2. Mining has not been a 'high-tech' industry historically."

"The industry functions as a series of isolated companies with no existing mechanism to pool its resources for the benefit of the industry. Each company is really not prepared, and largely unable to fund at this time, to sacrifice any of its own immediate priorities for the long term good of the industry."

Question 15 C): Researchers (Continued)

"Canada is unique with the degree of open information flow. Conservatism is the worst enemy of progress. Fear of failure/excess cost of new technologies a critical psychological/philosophical problem."

"Mind-set. Emphasis on short term gain EPS/DCT-ROI etc."

OPERATIONS

Question 15. Please comment briefly on your opinions and suggestions regarding:

C. The major barriers to technology diffusion in the mining industry.

"La méthodologie traditionnelle des méthodes de travail."

"Uncertainty regarding future prices and stability."

"Les couts et le temps requis pour informer aux qui decident."

"Communication and cooperation. Labour readjustments."

"Financial resources, risk, international market."

"Lack of cooperation on long term mining requirements."

"Training of mining engineers and technicians in new technology. High cost of capital and uncertain market situation."

"New technology highly specialized and therefore extremely costly."

"Unwilling to risk money."

"Shortage of suitable technology index."

Question 15 C): Operations (Continued)

"Lack of awareness of what is available by industry personnel . Inability to keep abreast of high-tech developments. Funding."

"Old style competition between industry competitors."

"Internal competitiveness and low metal prices and markets."

"The problem has been mainly a lack of cohesion within the mining industry on R&D matters. The poor economy and adverse conditions and poor information on federal R&D incentives haven't helped to improve things."

"Industry is generally conservative and resists application of unproven technology especially in tough economic conditions existing today.

"New technology cannot be readily applied to old mines. Mines, once developed have put in major capital in mining equipment and mining methods. To change it requires a lot of new capital that the industry cannot afford if changes are made in mid-stream. New technology also means less jobs which is not popular to any one in the industry."

"Il' y a obstacle seulement si la R&D est faite pas une seule compagnie - aucun obstacle si fait en association."

Question 15 C): Operations (Continued)

"Current economic climate and risk of failure."

"Lack of funds."

"University mining programs at undergraduate level need to improve their programs and lectures to keep pace with current and future mining conditions. Get rid of dead wood."

"Operating personnel too busy to sit down, peruse and digest all technical printed matter. Need clearing house for diffusion, such as the CANMET/CANPRO abstracts."

"Proven cost effective technology in materials handling and processing."

"Under present circumstances the company introducing new technology must know it will work and a quick pay off is required. This is difficult with new technology."

"Remoteness."

"The barriers are being removed by sessions like the Underground Operators' Conference and the Meek-Electrical Conference which lead to industry co-operation."

Question 15 C): Operations (Continued)

"People, unions and lack of capital."

"No in-field knowledge of new technology and its possibilities."

"There appears to be a reluctance of industry to be first in with new technology. Some operator must have accepted it and verified it."

"Lack of communication between government funded research agencies and the operating industry."

" Lack of knowledge at the operating level about the R&D which is being done."

"Blocked minds."

"Communication; identifying common needs and applications; critical mass for whole industry in common areas."

"Geographic extent of mining operations and the tendency of miners to go it alone."

" Competition between mining companies. Poor dissemination of information."

Question 15 C): Operations (Continued)

"Basic communications inadequacies."

"Time and capital."

"The patenting of new processes by larger organizations in order to charge potential users of the technology."

Question 15. Please comment briefly on your opinions and suggestions regarding:

D. What could be done to further assist the development and diffusion of appropriate technology?

The most common suggestion in this part of question 15 had to do with improving the communication between the various players in research and development and encouraging the free-flow of technology related information. Several mentioned CANMET Index as an example of a positive initiative. Others suggested more frequent regional forums and on-site seminars. Newsletters by unbiased sources were also mentioned.

Certainly the respondents felt that the dissemination of information could be greatly improved and that this would be an appropriate role for the government. Another suggestion really took the form of an identified need rather than an action and that was to develop closer liaison with universities, government and industry.

EXECUTIVES

Question 15. Please comment briefly on your opinions and suggestions regarding:

D. What could be done to further assist the development and diffusion of appropriate technology?

" I perceive the industry and professional associations as the best platforms for prompting technological development and diffusing technology. Unfortunately, such associations are coerced by the events of the industry's defenders against the bureaucratic and socialistic approach of various government bodies."

"Greater co-ordination of research activities with resulting increase in the diffusion of knowledge. A mining technology database, perhaps managed by an existing technology centre would assist."

" Improved economic climate."

"Development -closer liaison between universities, government and industry regarding needs of industry and emerging technologies. Diffusion -forums for diffusion exist ie. conferences, conventions, seminars - orchestrate them."

"More regional technology conferences, technical trade expositions would be useful."

Question 15 D): Executives (Continued)

"Have government support and participate in co-operative industry research ."

"Foster two way communication between industry and research agency personnel on a continuing basis"

"Government sponsored R&D co-ordinated internally to be more focussed (more practical) and communicated to the industry."

"Conduct a thorough scientific/engineering/economic analysis of each mining sector with the objective of identifying systematic technological changes that would have a revolutionary impact on production economics."

"To address the lack of co-operation among industry members we have to diffuse egos."

"1. An information/education program by EMR/CANMET to inform industry on purpose/scope/direction of tax incentives/government programs/ R&D project (in-house and financed through universities/private contractors/consultants)
2. Assistance in specific project development (both technical and financial) through pilot demonstrations."

"Leave the industry and universities with adequate funds and sponsor active exchange forums as well as information databases."

Question 15 D): Executives (Continued)

"Restructure CANMET to make it more responsive to mining industry and to serve as more effective disperser of technology."

"More complete and co-operative testing of technology by better and more open relations between industry and would be suppliers."

"Industry new technology shows."

"Necessity is the mother of invention. A very strong incentive or outside market threat is necessary . Get some very practical people in R&D, people who can make change happen."

"Improve integration of initiatives between mineral producers. Better co-ordination of R&D programs."

"Operators' conferences sponsored by appropriate industrial bodies. Government keep a low profile."

"Use CANMET and other agents to disseminate."

"Keep government and subsidies to minimum level. We cannot afford too many Cape Bretons."

"Government support of research and development efforts should be expanded through organizations such as MIROC and HDRK."

RESEARCHERS

Question 15. Please comment briefly on your opinions and suggestions regarding:

D. What could be done to further assist the development and diffusion of appropriate technology?

"A bridge between the development and diffusion or marketing is required. Government grants should be used to support manufacturers and mining industries to test the prototype and further modification of new technology or equipment."

"Through tax incentives and infrastructure development, especially in the north. Mining companies could generate more cashflow in order to pay for the development and installation of state-of-the-art technology."

"Bring CANMET back up to the level that it used to be when it was the "Mines Branch" and did useful innovative work. Expand the NRC technology office/database."

"Central database on applications of new technology"

"Develop tax incentives to share technology and for companies to work together to develop new technology."

Question 15 D): Researchers (Continued)

"Encourage participation of industry in conferences, professional and technical associations etc."

"More frequent opportunities for direct exchange of ideas."

"Establish a Canadian Mining Research Association and disband other groups duplicating mining research effort."

"Mine operators are much better informed than one might have the impression that they are. They are informed through conferences, workshops, demonstration projects, papers in specialized journals, etc. These should be encouraged and continued."

"Provide incentives and make appropriate commitments. Provide a basis for good communication. Need to streamline or perhaps through some central computer bank that provides access and feedback directly to mining firms."

"I think that the government could direct a lot its R&D costs at industry directly ie. contract with mining companies to have them develop the technology, with government funding and file the reports with government to become public property after a suitable period -say 3 years."

Question 15 D): Researchers (Continued)

"Include the end product use in technology development programs at an early stage."

"Government assistance in all respects. See Japan and Sweden."

"Promote a healthy industry. Back off on income tax, sales tax, water tax. Taxes are killing the industry."

"The need for a longer term program to enphasize the benefits of innovative procedures as items is a first step."

"A prioritized list of technology applications should be developed by mining companies. Areas of common interest could be investigated as joint ventures, while others investigated on an individual basis."

"Sharing of technology with other mining companies."

"The CANMET technology index is a good concept. CANMET can play an important role in facilitating/co-ordinating information."

"CANMET technology index is good."

Question 15 D): Researchers (Continued)

"To help diffuse the technology, good for the government labs to take a more active role in working on immediate technology problems. Work by government labs is seen to be unrelated to problems encountered day to day."

"Offset to LDC to buy Canadian products for Canadian installations. Would help create the need for more development and diffusion."

"Have more competent, expert professionals in federal and provincial R&D organizations. Ensuring that adequate means have been established for technology transfer through publications"

"Government could finance demonstrations and assist in implementation."

"Public funding"

"Obtain a reasonable and simple tax break for R&D expenditures. An R&D dollar should cost 25 cents after tax."

"Decrease metal/coal/oil/mineral prices even more to force the industry to more productive than offshore competitors - then increase the prices!"

Question 15 D): Researchers (Continued)

"Allocate funds and specialists to real problems/cost saving and efficiency increasing areas. Not the movement of paper."

"Business development managers who go to industry - meet end users to diffuse technology and develop new activities."

"1. Set up a good mechanism to be aware of state-of-the-art technology worldwide and to transfer it to mines.
2. Get practical engineers in R&D organizations.
3. Involve operating management in R&D programs, not R&D engineer only."

"The industry must know what technology exists worldwide that can be used and adapted. We in Canada are not big enough to invent the new technology. The government should keep abreast of worldwide technology and provide industry with state-of-the-art reviews of what is available so that industry can follow-up. We need knowledge and money to implement - not academic projects."

"Promotion of industry as high-tech business, which it is. Continued development of government, academia, industry linkage requires more selling from government labs, technology centres and universities. Industry is often too busy fighting fires to design a better fire retardant."

OPERATIONS

Question 15. **Please comment briefly on your opinions and suggestions regarding:**

D. What could be done to further assist the development and diffusion of appropriate technology?

"Continue in initiatives, but industry should be more involved in setting up federal/provincial MDA's."

"Definition of and co-ordination for common problem solving."

"Approach similar to U.S. Bureau of Mines."

"Joint industry/university R&D projects."

"Send mining executives to Sweden to learn to understand their approach to R&D."

"Government assisted programs to send mine operating personnel to see state-of-the-art operations in the rest of the world, especially Europe."

Question 15 D): Operations (Continued)

"More symposium/seminars on new technology. Government funding of new technology - joint venture. Credibility and results oriented (practical) research groups."

"Future training in mining technlology, valve analysis etc."

"Commitment and increased co-operation between universities, government, mining industry and manufacturers. Intensive communication is also required for data collection, research, analysis and dissemination of findings."

"Il n'y a pas de recette miracle au progres. Continuer ave patience et tenacite."

"Any method to foster information and visit exchanges between Canadian mining and beneficiation engineers."

"Assistance technique d'une équipe specialisée qui visiterait régulierement les site miniers."

"Government stop taxing industry to death so it would have funds. Government stop investing in helping LDC's to compete. Government simplify procedures for assistance."

"Independent competent publications not biased by advertisement qualifiers."

Question 15 D): Operations (Continued)

"Before technology leaves R&D centres there should be a field trial to determine whether it is practical - can be adapted - can be used and not a dream."

"Any research facility should be able to invite specialists to assist in particular problems. Periodic reports be issued to all parties involved."

"Identify the real problems then work to solve them and do not spend money on idealistic non-profit ventures."

"On site lectures and seminars."

"Impliquer les manufacturiers, universites et operateurs."

"Enhanced investment tax credits for new technology much like exploration and approved research grants at present."

"Make research more attractive to operating mines through tax incentives and help industry earning increase to free up capital."

"Dedicate more time for knowledgable people (government) to spend in the field offering suggestions . Must be more than a cursory look-see, they must spend at least 2 weeks at an operation to be able to offer meaningful suggestions."

Question 15 D): Operations (Continued)

"Better communications and monetary incentives."

"An industry newsletter featuring companies that have used new technology. This would be similar to some of the equipment newsletters put out by various suppliers."

"Adequate meetings are held but sometimes small companies just can't afford to send young engineers to meetings. Government aid might help. Possibly tours of mines by technical people from universities and government could help diffuse technology."

"Greater co-operation between industry, government and suppliers."

"Demonstrations."

"More technology centres sponsored by participants. Not government funded or controlled. Independent organizations. Profit or non-profit."

"Present efforts to collect and make available technological improvements by the Mines Ministry are to be encouraged. Increased competition, while healthy inhibits the free exchange of information."

Question 15 D): Operations (Continued)

"Improve communications through technical societies, government presentations and information seminars."

"I think industry needs to be better informed of government funded work completed and available to the industry."

"Capital has to appropriated for such activities and companies have to commit themselves to long term training of employees in order to implement these projects."

"A single co-ordinative body and information clearing house would be beneficial. Federal government R&D bulletins is a step in the right direction."

"A central clearing house for informing the industry as to what is being done and by whom."

Question 15. Please comment briefly on your opinions and suggestions regarding:

E. The role of various players in research and development.

Again the need for co-operation and co-ordination was underlined in the responses to this question. Generally, it is perceived that industry should provide clear direction on the type of research and development undertaken and the specific project. Government should act as a 'catalyst' or a 'facilitator' as well as financial supporter to universities to help develop new technology.

EXECUTIVES

Question 15. Please comment briefly on your opinions and suggestions regarding:

E. The role of various players in research and development.

"Industry can identify the needs, the suppliers can produce the required technology. Consultants play a part in augmenting expertise."

"Universities- long term generic research.
Government Laboratories - long and short term research .
Technology Centres/ Industry/Industry Associations - short term research. "

"Industry must input its ideas on what is required. Researchers must hear and respond. Government bodies must co-operate to get the job done."

"Government funded research should only aim at goals that Canadian mining firms may implement in the near to mid-term. Must be potentially unmarketable in or by Canada."

"Management must have an innovative bent."

Question 15 E): Executives (Continued)

"Universities - fundamental research, government and associations applied research."

"All players have a role and R&D must be more specific and on many fronts."

"Need co-ordinated effort by governments, universities and industry."

"Industry is key player. Financial constraints are major deterrent to R&D."

"Companies - identify specific R&D potential. Technological groups to provide source of skills and expertise to work on prototype or pilot process. Manufacturers to develop and distribute the commercial application."

"CANMET needs funds to do research as well as pay salaries. "

"In my opinion, sectorial research organizations established for the various sectors of the industry with the collaboration of governments and business are the most effective. A national research establishment could then co-ordinate the activities of the sectorial groups and pursue projects of academic groups as required."

Question 15 E): Executives (Continued)

"Industry is prepared to take the lead but would appreciate more support from government agencies."

"Government agencies, for example CANMET, and industry associations could use more initiative to focus and co-ordinate R&D at common industry problems like noise abatement."

"Industry must define its R&D priorities to the research agencies, many of which have a dual role in addressing these plus longer term projects. The proliferation of research agencies, between federal and provincial agencies leads to difficulties in defining roles between each and very probably to excess expenditures because of lack of co-ordination or duplication."

"In-house R&D personnel, dedicated to projects of corporate importance, are most effective. University researchers can be helpful if informed and involved. Government agencies experts and policy makers are generally fringe players because of their arms-length relationship with major production centres of the mining industry."

"The role of both private and public sector is to stimulate the 'entrepreneurial' nature of R&D, and try to spend the monies intelligently."

Question 15 E): Executives (Continued)

"R&D must have the involvement of industry representatives. Technology developed by academia (university, government and labs etc.) is generally so far from reality that application is beyond the scope of any mining company."

"Industry should be prepared to match government funding on demonstrable R&D with an immediate impact (implementation within 3 years). However, governments will have to carry the long range projects with an impact beyond 10 years."

"To be effective, R&D must be applicable to real live problems that are economically opportune to solve. The practical level of development is best done in an industrial operation. The academic community can supply the intellectual curiosity and theoretical analysis. Government should only fund and encourage."

RESEARCHERS

Question 15. Please comment briefly on your opinions and suggestions regarding:

E. The role of various players in research and development.

"Funding should be made available for specific research related to mining areas but the main thrust should be under one Canadian Mining Research Association."

"A balance between pure research, applied research and technology transfer is important. In difficult times, shorter term research should be emphasized, but research should continue to occupy an important place in mining."

"There should be a close collaboration and technology transfer between all concerned - management, technical personnel and the ultimate end users of the technology."

"To keep abreast of related technology and to contribute to the corporate profit through technological improvement, cost reduction programs and improved product quality."

Question 15 E): Researchers (Continued)

"Mining companies have the problems and need the solutions. R&D (private or government) have the resources to match and many new developments to create economic solutions to the problems. Government to provide fair incentives for the above to occur."

"He who spends the money on R&D should reap the rewards and own the technology."

"CANMET has been emasculated by bureaucracy so most outside R&D is done under contract with universities or specialist firms (i.e. Lakefield Research, Wittech). Why not reactivate CANMET?"

"University - basic research; research institutes - applied research; mining industry -modification or development."

"Various R&D work must concentrate on immediate problems to try and help the mining industry to survive the difficult times that are being experienced presently."

"1. Government to provide up to date, state-of-the-art reviews in available technology.
2. Industry to get its act together to pool its expertise, objectives and money.
3. Government to assist with money and expertise to make work in industry appropriate pilot projects."

Question 15 E): Researchers (Continued)

"Industry should co-ordinate and fund its efforts jointly.

- Better management of R&D organization and more funds.
- Two key roles of R&D must be to disseminate information and provide training/professional development for operating personnel."

"Government bodies, universities etc. responsible for generalized research. Industry responsible for financing site specific projects."

"R&D centres and organizations do not have a bridge for communication - both too busy. Requires full time business development managers in R&D organizations."

"Industry - testers and users; government, academia - developers and promoters; suppliers, manufacturers - commercializers."

"Not much use without high level sponsorship - will just bang one's head against the wall. Need to do a terrific selling job. High level sponsor with lots of credibility to lead a group or separate R&D organization - would have access to existing departments - operations, project development."

Question 15 E): Researchers (Continued)

"1. A relatively small administrative group possibly set up through MAC.
2. Representative committee from industry with senior technological representation to meet semi-annually.
3. R&D carried out through mining firms, supported by CANMET, universities etc."

"Operating mining companies are in the best position to determine their needs and assign priorities. Somehow these directives must be translated into a combined effort between universities, governments, research organizations, manufacturers and industry to implement and develop the technology."

"Industry should take the lead role, supported and co-ordinated by government."

"Government help by tax assistance and information gathering, foreign sales; industry develop technology with government help."

"Government should actively promote industry's research - more effort as facilitator."

"Go ahead knowledgable people, supportive management, cash flow and mine life."

Question 15 E): Researchers (Continued)

"Government should be a catalyst, not a prime mover."

"Government should encourage and assist in financing. Industry should search for methods to increase productivity and find new uses for Canada's resources. Unions should be knowledgable and co-operative and willing to work toward change. "

"There appears to be too many groups which spread senior technical people within a particular organization too thin."

OPERATIONS

Question 15. Please comment briefly on your opinions and suggestions regarding:

E. The role of various players in research and development.

"Développer la communication personnelle et directe entre les intéressés."

"There is a need for less emphasis on the bureaucracy of mining and more on productivity and innovation."

"Government should encourage research through funding. Universities and federal laboratories should become centres of excellence in particular areas of needed technology. Companies should view R&D as investment and work together with universities on projects of mutual interest. Manufacturers should look at the needs of the industry to stay competitive."

"Company training co-ordinators could liaise with R&D outlets and create atmosphere of awareness with technical personnel."

"Better to provide government researchers to industry for technology trials. Application of technology more difficult than lab trials - emphasis on field evaluations by government - work with industry."

Question 15 E): Operations (Continued)

"R&D tend to be too highly specialized, more emphasis should be spent on improving efficiencies in standard mining methods and for narrow vein mining which has been left behind."

"Various groups should work together."

"Combined efforts of companies, governments and manufacturers or suppliers is conceivably the best way to implement new technology. Government incentives are a must to allow this to happen with the current depressed state of the industry."

"Efforts seem dispersed and disjointed presently, with initiatives being taken but in an unco-ordinated manner."

"Industry is the most important player in applied technology, universities and governments in basic research. Question whether government research is cost effective (better to reduce industry taxes by eliminating government spending, also channel more funds to universities).

"There are currently too many centres, funded by taxes, doing research without central co-ordination leading to duplication of effort and competing for funds/projects."

Question 15 E): Operations (Continued)

"Let companies do their own research, don't tax away the money and then hand it back."

"Government might fund a test mine where industry can test innovations where they do not interfere with production activities."

"Government funded research should be confined to basic theoretical or scientific problems."

"Leave it to those who can profit by it."

"Government should not extract money from the industry and return it in the form of R&D grants."

"Generally there is interest lacking. Associations should centralize their efforts in R&D to reduce duplication."

"A very basic role, without which stagnation and death. Remember the dinosaur."

"Government - provide funding; consultants -expertise; industry- ideas , environment, inspiration."

"Industry representation on committees which oversee research. Government to fund. University installations should be greater. Industry objectives should be more visible."

Question 15 E): Operations (Continued)

"Government and industry to fund. Industry to guide and direct, to provide test areas when necessary, to second personnel. Research facility to research diligently, issue progress reports, with aim of increasing productivity, improving safety etc."

"Researchers should also work on intelligence regarding work being done in the replacement of materials having existing production bases, ie. identify technology being developed elsewhere and communicate these concerns to established producers."

"Here, research is carried out by production oriented ppeople which has many advantages, but limits their time spent on research and also limits their outlook to a certain extent."

"Identify the needs and work at developing solutions."

"Government and industry should support research at universities and colleges."

"Companies should be encouraged to devote more money to R&D through tax incentives, government help (people), visits by university people to describe their abilities etc."

PART V Subsample Results

As mentioned in the General Profile Section, the sample group comprises of 32% underground only; 26% open-pit only; 37% mixed and 36% smelters. For the most part, the subsample results are similar to each other but there were a few interesting differences which are summarized in this part of the report. These differences are generally most marked between respondents from underground only operations and the respondents from open pit only. For instance, while only 23% of the underground only operators indicated they used government laboratories as a source of information on new technology, 52% of open pit operators and 54% of the mixed operators claimed to use these labs. The following charts are included to highlight where these type of differences occurred.

Question 3: Please rate the following factors in terms of their potential contribution to profitability and rank the top five

Percentage of Positive Ratings

Factors	U/G	O/P	Mixed	Smelters
1. Management	89%	86%	88%	85%
2. Labour Force	73%	66%	87%	39%
3. Cost Control	72%	82%	69%	68%
4. Equipment Maint.	60%	65%	58%	58%
5. Exploration	36%	23%	40%	37%
6. End Product Devel't	24%	27%	17%	21%
7. Marketing	33%	56%	39%	34%
8. Technology	54%	64%	63%	69%
9. Diversification	13%	24%	18%	20%

Percentage in Top Five

Factors	U/G	O/P	Mixed	Smelters
1. Management	73%	75%	73%	76%
2. Labour Force	70%	68%	72%	65%
3. Cost Control	60%	69%	64%	59%
4. Equipment Maint.	57%	56%	47%	47%
5. Exploration	36%	15%	25%	18%
6. End Product Devel't	11%	12%	7%	7%
7. Marketing	20%	51%	30%	27%
8. Technology	36%	64%	62%	53%
9. Diversification	5%	5%	12%	16%

Question 4: What level of utilization of state-of-the-art equipment/processes would best describe your operation(s)?

Levels	U/G	O/P	Mixed	Smelters
All state-of-the-art	11%	6%	6%	8%
Mostly	33%	50%	54%	45%
Some	53%	44%	38%	45%
None	3%	--	2%	2%

Question 6a: Does your firm have a formal research and development or technology development group?

AND

Question 6b: Does your firm have a person or group responsible for technology planning?

	R&D Group Percent Yes	Tech. Planning Percent Yes
Underground Only	38%	30%
Open Pit Only	67%	52%
Mixed	65%	59%
Smelters	77%	61%

Question 8: Please indicate which sources of information you currently use to keep abreast of new technologies.

Sources	U/G	O/P	Mixed	Smelters
1. Trade Journals &Pub.	96%	100%	98%	98%
2. Newsletter & Bull.	71%	81%	85%	82%
3. Prov. Res. & Tech.	25%	55%	56%	61%
4. Seminars, Conf.	58%	81%	75%	79%
5. Colleges & Univers.	35%	48%	59%	68%
6. Consultants	77%	69%	76%	70%
7. Suppliers	73%	83%	90%	91%
8. Gov't Laboratories	23%	52%	54%	48%
9. Ind. & Prof. Assoc.	52%	52%	71%	75%
10. Visits to Cdn. Firms	75%	83%	90%	86%
11. Visits to For. Firms	35%	71%	68%	73%
12. In-House Expertise	73%	88%	83%	86%
13. Exhibits & Shows	50%	57%	63%	64%
14. Personal Contacts	79%	88%	95%	89%
15. Gov't Departments	33%	41%	51%	50%
16. Bus.&Tech. Databases	21%	36%	32%	39%